The Journal of the Biological Photographic Association

Volumes I and II

Baltimore, Maryland
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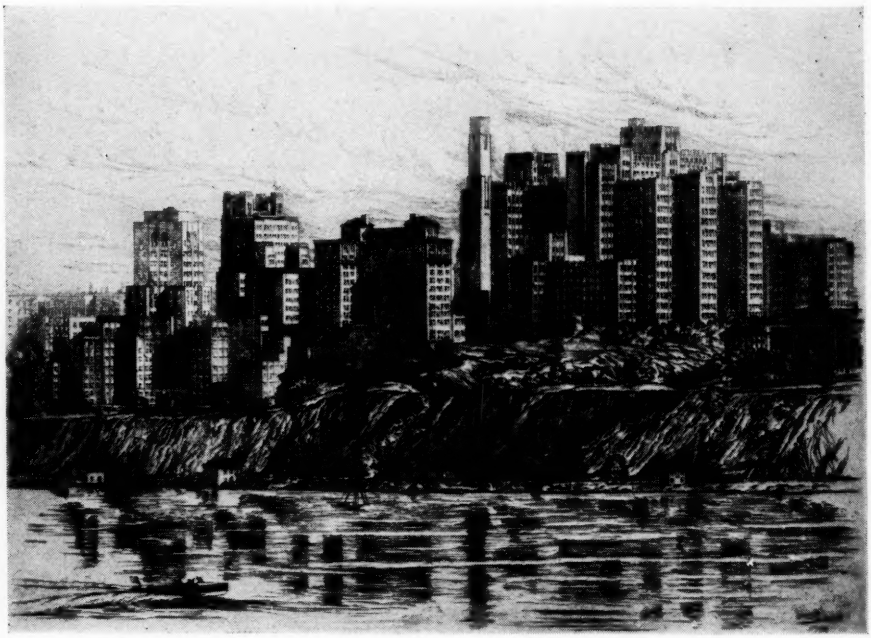

From an etching by Louis Schmidt, courtesy of the Purnell Galleries

COLUMBIA UNIVERSITY
PRESBYTERIAN HOSPITAL MEDICAL CENTRE
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Journal of the
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VOLUME 1 SEPTEMBER, 1932 NUMBER 1

EDITORIAL

The Convention of the Biological Photographic Association

DUE to the long-felt need on the part of biological photographers of getting together and discussing ways and means of producing perfected biological photographs and standardizing procedures, the Biological Photographic Association was formed at Yale University in September, 1931. This Association met with such profound enthusiasm on the part of photographers employed by teaching institutions that it has grown by leaps and bounds in a remarkably short time. This journal is the outcome of a second meeting held at Rockefeller Institute for Medical Research and Columbia University of New York City in March of the following year. Approximately one year after the organization of the Association its members, as well as many prospective members, have received the first issue of this journal. It is sincerely hoped that they will not only find the journal interesting but highly constructive as an aid in biological photography.

The time has now come for the second annual convention of this association which will be held at the School of Medicine of Yale University in New Haven, Connecticut, on October 21 and 22 of this year.

At this meeting many interesting papers will be read on photography in relation to the biological sciences. New equipment and processes will be discussed. There will also be an exhibit of outstanding biological photographs. Under each picture will be given complete data as to the apparatus and technique of production. Commercial firms will have exhibits of their apparatus. It will indeed be an opportunity for photographers to observe the results of new advancement and learn more about their profession.

Those interested in these subjects are heartily invited to attend this convention.

THE PRESIDENT'S MESSAGE

PHOTOGRAPHY in association with biology has grown in importance through the years to the point where it is now almost indispensable as an aid in teaching, in dissemination of knowledge, and in scientific investigation. In its development, photography, like many other technical and scientific fields, has shown a marked tendency toward subdivision. We employ now not only gross

RALPH P. CREER
President of the Biological Photographic Association

photography, but also photomicrography, microphotography, color photography, and motion picture photography as well. Fortunately, specialization has not yet advanced as far as medicine, and the man who makes a photograph of the left leg can still make one of the right.

Nevertheless, the complexities of photography in relation to biology are such that it is no longer easy for the photographer to become adept in all the branches of his work and at the same time keep abreast of all developments which may have value to the teachers and investigators whom the photographer is trying

to aid. It is clear that much could be gained by an occasional exchange of ideas and by demonstration which would give to many photographers the knowledge and skill which the individual might be able to develop in some particular aspect of photography.

These were the considerations which led to the formation of the Biological Photographic Association. On September 11, 1931, representatives of a score of medical schools and other scientific institutions in the East met at the Yale University School of Medicine, and established a permanent organization. That organization has since had a second general meeting at Rockefeller Institute and Columbia University. At the conventions a lively interest has been shown in the exchange of ideas, and this exchange is now facilitated by the publication of a quarterly journal, THE JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION, under the editorship of Carl D. Clarke, University of Maryland.

This Association must remain unselfish in its aims. It must not be used for purely self-protective purposes; it is not a trade union. Its purpose must be to help and stimulate its members so that biological photography may be employed ever more efficiently in its primary purpose, namely to further the study of photography in relation to the biological sciences and to improve its technique.

SOME PRACTICAL CONSIDERATIONS ON TIME LAPSE MOTION PHOTOMICROGRAPHIC DEVICES*

OSBORNE O. HEARD

From the Department of Embryology, Carnegie Institution of Washington, Baltimore, Maryland.

A YEAR after Edison demonstrated his kinetoscope in New York Marey was using celluloid roll film in his work on movements, and by 1894 the first microscopic object, a vorticella, was photographed to analyze its motion. It was from these experiments that motion photomicrography or *"micro cinematography"* had its origin and it is rather interesting to note that biologists used the motion picture as a research tool from its inception. The early development of the technique by the French yielded remarkable results and it is only recently that American scientists, especially biologists, have used it as an instrument of research. Phenomena too fast or too slow to be observed by the microscopists may be accurately recorded either by the use of "slow motion" or "time lapse" photography and the resulting film studied at will. The ingenuity that has been displayed in constructing the various devices makes an interesting story. The problem to be worked on has in each case influenced the type of apparatus evolved.

Two well-known optical companies have offered instruments and these may be briefly mentioned before discussing the several "homemade" apparatuses in detail.

A small equipment of Bausch and Lomb Optical Co., which uses 16 mm., has a rather limited application. Excellent results have been obtained by the originators, Tuttle ('27), Bayne-Jones and Tuttle ('27) and Heinz Rosenberger ('30). Unfortunately if maximum resolution has been obtained on this size film it cannot be transferred to standard 35 mm. film without appreciable loss, whereas the larger film may be reduced to the smaller with precision and excellent results. E. Leitz Inc. offered in 1923 their "Universal Photographic Apparatus for Micro- and Macro-Moving Pictures" based on the early Ernemann arrangement. More recently they have woven a new set-up around their Edinger

* Received for publication July 1, 1932.

stand. These instruments by Leitz are compact and would require many changes before they could be used for time lapse work. Normal speed might be used successfully but the experience of many workers indicates that each unit in the set-up should be divorced to prevent transmission of vibration.

A brief résumé of the application of the motion picture in biological research may indicate its diversified use. M. S. Weiss ('96) in his experiments on the contraction rate of muscle fibres used *"chronophotographie."* These experiments were carried out at the Marey Institute in Paris where the pioneering work in micro-cinematography was done. He successfully employed a water immersion lens and a modified Marey chronophotographique apparatus. Many changes occurred in motion picture devices during the period between 1894 and 1909 prior to the classical work of Comandon ('09). It may be of interest to note that the essentials of the methods now in common use were employed by Comandon. The horizontal arrangement of his apparatus is a striking feature. The clock driven segmental shutter and camera were directly connected by a common shaft. The driving mechanism was placed near the microscope. The modified Pathé camera was attached to the microscope by a relatively long bellows, probably 30 cm. long. The object was observed through a tube mounted on the back of the camera. A focusing rod extended to within easy reach of the observer and the entire equipment was mounted on rigidly constructed tables. He pointed out the necessity of avoiding vibration. Ries ('09) working on echinoderms during the same period visited the Marey Institute and devised an apparatus in which the microscope was placed in a normal vertical position and the image reflected 90° by a prism being placed over the ocular. A long bellows was used to connect the prism mount and camera. A movable viewing mirror was inserted in the path of the image rays as part of the camera. This essential feature of every micro cinema device he found to be quite useful for focusing the image, centering, and controlling the time of the scene.

From the time of these initial experiments marked progress has been made in equipment and materials. The acme of this advance is found in the Heinz Rosenberger, Fig. 6 ('29), a standard micro-cinematographic apparatus of the Rockefeller Institute for Medical Research. The recent results obtained by Canti ('28),

Lewis and Gregory ('29), Patten and Kramer ('32), and those workers dealing with colloids and crystals, etc., establishes the micro-cinematographic apparatus as an indispensable tool in scientific research.

The author assembled in 1928 the apparatus used by Dr. Warren H. Lewis of the Department of Embryology. There being a necessity of revamping the apparatus, a survey of available literature has been made. The problem of *exact* "time lapse" has not been adequately solved and it is hoped that the survey and discussion of the various devices may lead to an apparatus that is exact in its time relationships, quite stable, and relatively inexpensive. The following is an attempt to scan those devices that have been published recently and to indicate their points of excellence. No review of motion photomicrographic apparatus has come under the author's observation and it is hoped that the widely scattered material and bibliography which is assembled may be an aid to those interested in this field of work.

SUPPORTS

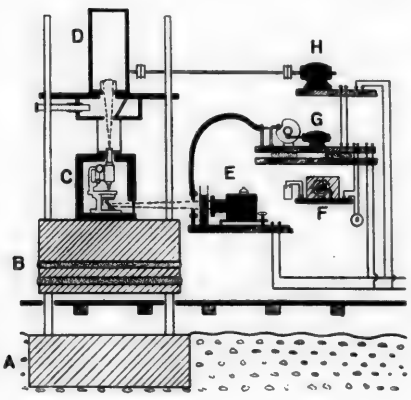

FIG. 1. Diagram of the Canti apparatus. A. Concrete Foundation. B. Block to absorb vibration. C. Incubator. D. Camera. E. Illuminant. F. Electric time clock. G. and H. Power units for actuating shutters and camera. Published with acknowledgment to Dr. R. G. Canti.

A good foundation is the first problem that must be solved. It presents many difficulties, in fact the chief difficulty in designing and assembling an instrument such as we are discussing. Stability is the first requisite but it should not prohibit easy and comfortable access to the microscope and its immediate vicinity. Ample room for accessory instruments should be provided but this should not in any way interfere with the rigid support for the microscope. In Fig. 1, these conditions are not met with. Stability has been obtained but at the sacrifice of

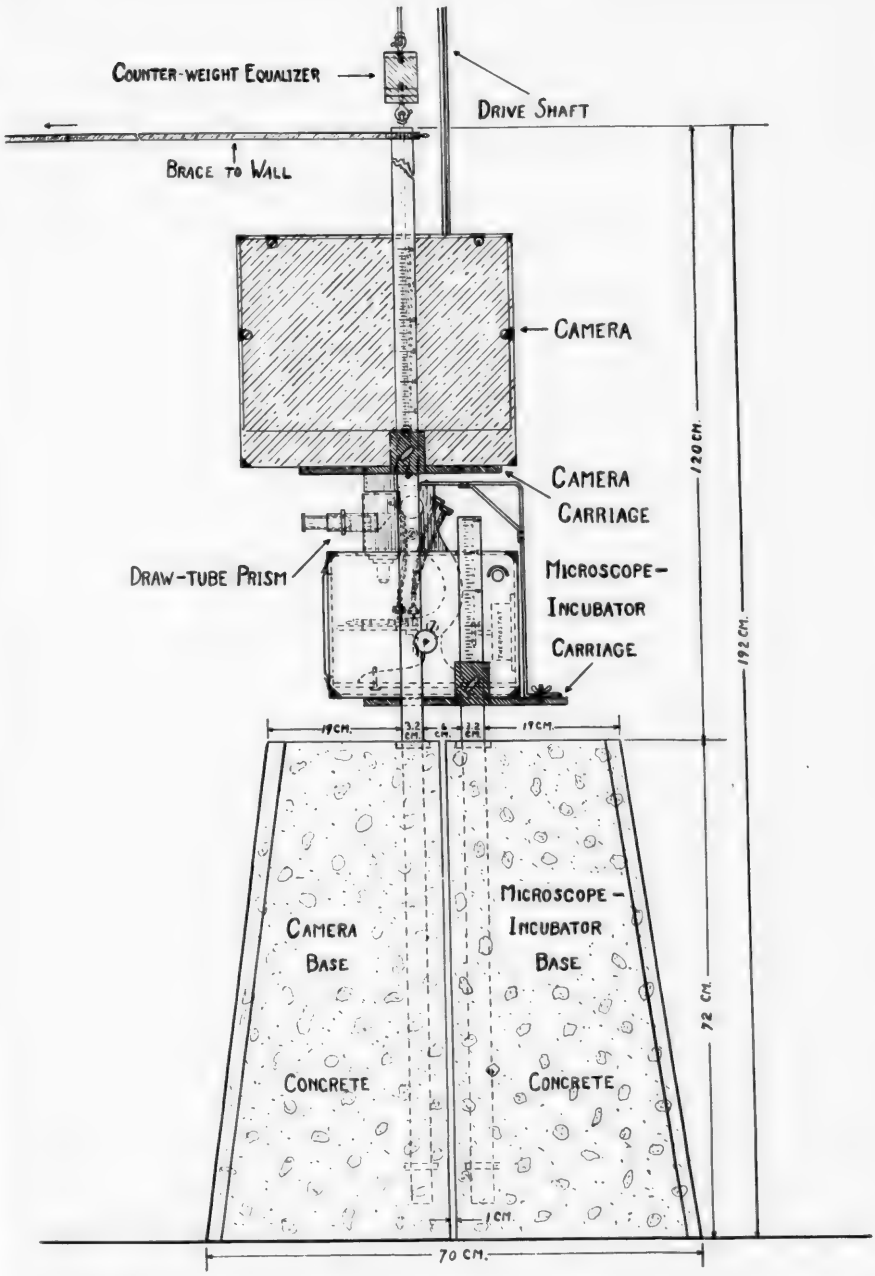

FIG. 2. The microscope and camera supports as arranged by Patten and Kramer. The supports are not in contact. The camera carriage is counterbalanced. The zinc cut for this figure has been furnished through the courtesy of the Wistar Institute of Anatomy.

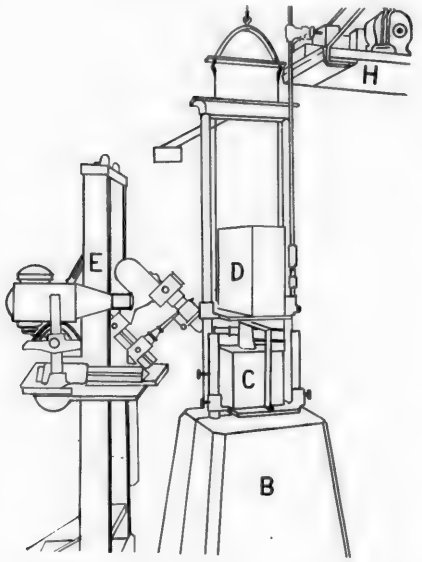

FIG. 2a. The Patten and Kramer arrangement. Note the portable lighting unit. Figure modified after the author's Fig. 1.

equipment which consisted of a shelf supported by brackets from a wall. The microscope and optical bed in the early Rosenberger set-up were mounted on a low, stockily built table and the resulting films established his reputation as a micro-cinematographer. The two storied table design of this laboratory (Fig. 3) has proved adequate for speeds as high as 24 r.p.m. but beyond this, destructive vibrations occur. In the new Rosenberger apparatus (Fig. 6) the supports are massive and well placed, though the microscope and convenient working conditions at the microscope. Fig. 2 is a better solution of the problem but it is probably a difficult matter to observe comfortably over a long period. Concrete was used in these bases. By the use of this inexpensive material, mass may be obtained, which is so essential to rigidity. Where "time lapse" results are the sole aim, massive supports are hardly required. This has been demonstrated in this laboratory and by Heinz Rosenberger ('27) in his earlier

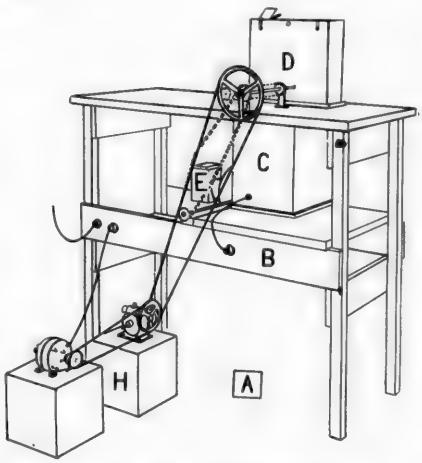

FIG. 3. The table arrangement of Dr. W. H. Lewis. The Power unit and table are easily moved to any part of the laboratory. The reference letters indicate similar parts for this figure and for figures 1, 2a and 6. This figure is published with acknowledgment to Dr. W. H. Lewis.

incubator support appear relatively light. In this device one can observe comfortably, but care would have to be exercised not to touch the support. In the semi-portable outfit of Loveland (Fig. 5) the tripod camera support has been nicely handled and this principle could be applied in supporting other members. The

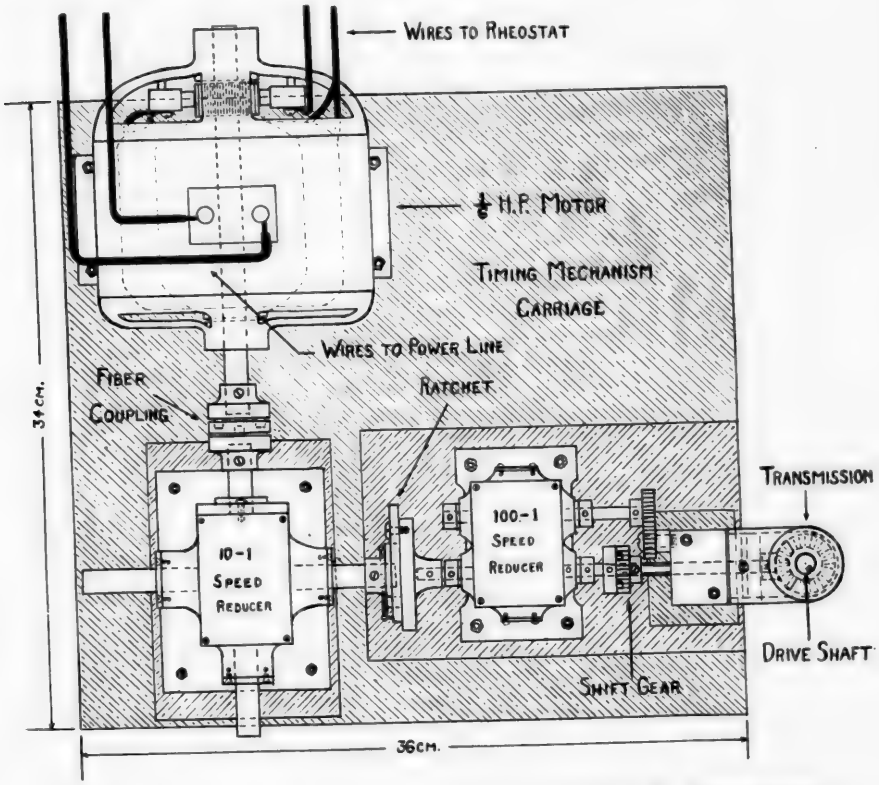

FIG. 4. The Power unit of Patten and Kramer showing the arrangement of the motor and speed reducers. Cut supplied by courtesy of the Wistar Institute of Anatomy.

"Geometric Slide" of Lord Kelvin (Fig. 7) after Barnard and Welch, is one of the most accurate and easily constructed mounts yet devised. This type of mounting securely fastened to a rigid support makes an ideal optical bench and would lend itself to horizontal equipment. Where micro-dissections and experiments are being carried out on or around the microscope it is better to insulate the table carrying accessory instruments from the microscope support. For this and several other reasons comfortable

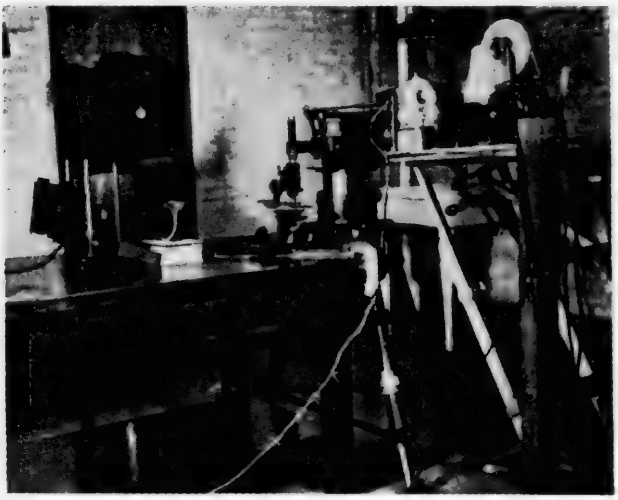

FIG. 5. The semi-portable 35 mm. set-up of Loveland. The tripod camera support weighs 500 pounds and was designed by Loveland. The halftone block has been loaned through the courtesy of the author and publisher.

working conditions should be provided when designing supports for the microscope and camera.

CAMERAS

There are several cameras on the market that lend themselves to motion photomicrography including the Universal, Moy, Newman-Sinclair, etc. With the advent of sound in the professional field many good cameras have found their way into the second-hand market and may be purchased for a mere fraction of their original price. The Universal camera has been used by Loveland ('32) and Lewis ('29). This camera lends itself quite nicely for "time lapse" work. Besides containing many good features, it is easily arranged for recording the image of a timepiece in one corner of the frame. The mirror that is usually supplied with the film viewing device is replaced with a prism. A totally reflecting prism eliminates the faint secondary reflection found when using the ordinary mirror. The viewing lens is removed so that a 50 mm. or 75 mm. photographic lens may serve to record time or titles. If the lens is mounted so as to be adjustable, typewritten titles may be photographed with ease without moving the camera from its support. The Moy camera used by Canti ('28)

and Patten and Kramer ('32), has a direct film viewing device with an observation tube running from the back of the box to the film. With the film magnifier removed, a prism inserted and a

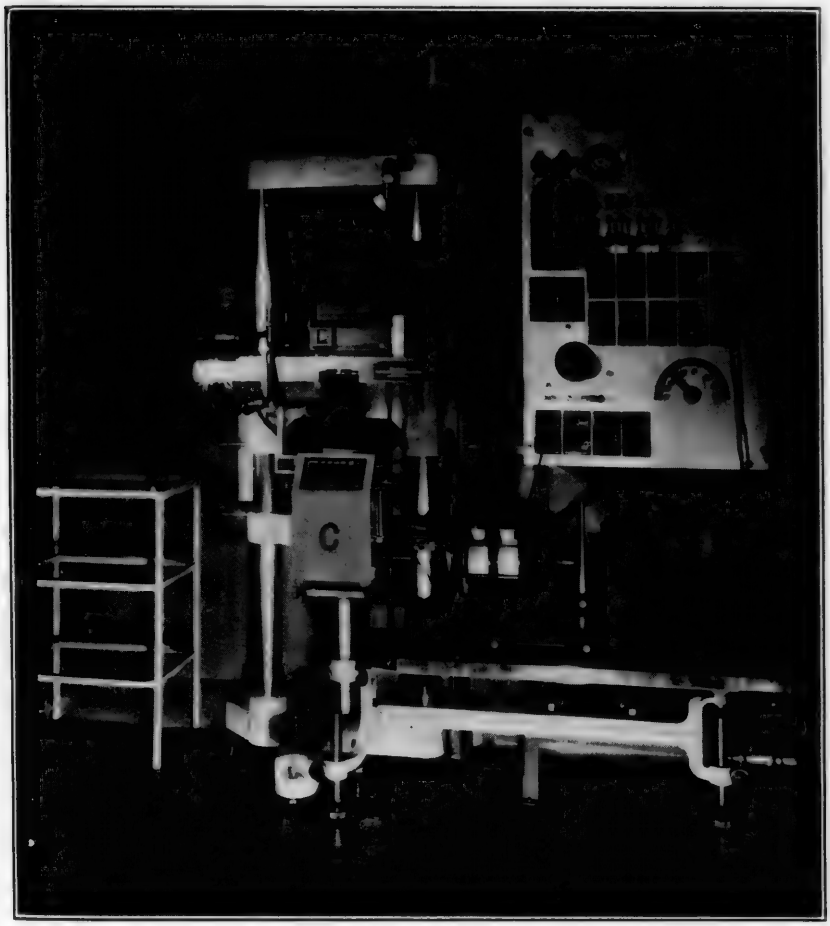

FIG. 6. The Standard Micro-Cinematographic Apparatus of Rosenberger, Patent No. 1794499. The designer's wide experience is reflected in every feature. This undoubtedly represents the finest device that has ever been assembled. Photograph published through the courtesy of Mr. Rosenberger.

short focus lens mounted near the film, time condensation may be recorded. Where 60 cycle alternating current is available the electric clock should be used to indicate time. That the image of the clock may not overlap the film image from the microscope,

a small dodge is fitted into the frame of the camera. Then there is the further possibility of the region of the clock being recorded. This must be entirely eliminated by either masking the region of the clock or placing a mask in the camera with a suitable aperture over the back of the film aperture.

In old cameras, the reciprocating parts should be gone over carefully for lost motion and wear. A second hand Moy camera has been used for "slow motion" work by Patten and Kramer ('32). They found that 40 frames per second could be taken which indicates how well they have solved the problem of vibrations at low magnification.

MICROSCOPES

There was a time when a student's microscope, pile of books, hand camera and electric light constituted a photomicrographic set-up. To do first class work a microscope of the research type with nicely fitted parts is essential. Improvisions take time. They may be absolutely essential to solve some photographic problems, but if one can purchase a research stand with focusing stage, centering objectives, centering substage and set screws to maintain a constant focus over a long period much of the worries one experiences in this work will be eliminated. For work with reflected light, either a metallurgical stand is required or modifications such as Patten and Kramer ('32) employed. For work with tissue *in vitro* the adjustments of the microscope must be made at the temperature required for maintaining the cultures. The body tube should be locked in position, cultures placed in special slides with plane surfaces and not mounted in or over hollow ground slides. Here is a source of optical trouble not yet adequately solved for the cytologist working with explants on cover slips. A large tube is essential and if provided with a side-view tube so much the better. Patten and Kramer ('32) used an E. Leitz but substituted a cover glass for the 45° prism. The viewing device of Canti ('28) was employed with modifications by Lewis ('29). In the Lewis ar-

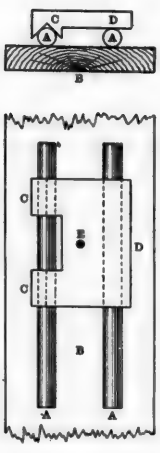

FIG. 7. The Geometric Slide, from "Practical Photo - Micrography" by Barnard and Welch, Edward Arnold and Co., London.

rangement the position of the thin cover glass reflector becomes an integral part of the camera, i.e., the position of the reflector remains constant in relation to the camera aperture, and the image is viewed on a plane equidistant from the optical axis with a magnifier. The light loss is in the neighborhood of 5% with this arrangement. The beam splitter of Tuttle ('27) and Loveland ('32) requires a fixed position for the miscroscope, without ocular (optically very poor with apochromatic objectives), prism, film and viewing ocular, and do not allow adjustment for exact magnification which is so essential in embryological and certain cytological research. It may be indicated here that Comandon ('09) and Ries ('09) used a long bellows, as is the usual custom in photomicrography, with excellent results. An objective of just adequate resolution with a longer bellows yields results which show depth of focus and flatness of field. Any device which places the camera over the microscope, and this appears to be the most common practise, defeats putting a long bellows in the system. The early horizontal devices yielded beautiful results of segmenting echinoderm eggs, *spirochetes,* and *trypanosomes.* The light loss, due to interposing a prism above the ocular, is never over 15%. The arrangement of the camera in a horizontal position would tend to keep the center of gravity low and reduce the amplitude of any vibrations that might be set up by moving parts. By placing the apparatus in a horizontal position with the microscope vertical, a movable prism or mirror viewing device could be placed in the image path as was done by Ries ('09). All workers agree that there should be no physical contact between the camera and microscope which indicates a light lock without contact.

DRIVING MECHANISMS

The earliest devices were driven by clockwork, but with the introduction of the electric motor, the clock driven apparatus has become almost obsolete. E. Leitz "Askania" camera and the "Ica Kinamo" are driven by clockwork for normal speed and are not readily adjusted for time lapse work. The present tendency is either to have a continuous drive with synchronized shutters for exposure and reducing the light falling on the specimen, or an intermittent arrangement using an electric timing device with motors and relays for operating the various elements. Canti ('28) used an intermittent movement with an electric clock arranged

to deliver electric impulses at required intervals. There was no motion imparted to the camera during the period required for the exposure. This arrangement is more complicated than the continuous type of drive but is undoubtedly the ideal from a photomicrographic point of view. The recent application of the synchronous motor by Rosenberger (personal communication) indicates that this type of drive should yield speed results within one-half of one per cent providing belts are eliminated in the driving mechanism. The experience of Dr. Warren H. Lewis indicates that where belts are used, exactly timed results cannot be expected. The solution of the problem lies in the application of a flexible shaft or rubberized shaft coupling from the power unit to the camera or other moving parts. The separation of the driving unit from the camera and microscope support is imperative. The "floating power" unit of Loveland ('32) is ideal for a portable outfit but cumbersome for a permanent laboratory setup. The Patten and Kramer ('32) power unit is ideally placed but high speeds might cause a whip in the drive shaft that could set up annoying vibrations. The flexible though inefficient power unit of Lewis ('29) is not recommended. The Patten and Kramer power layout (Fig. 4) is a far better solution, though the author would recommend the removal of the bevel gears and transmit the power by flexible shaft from the unit so that the gears are entirely removed from the camera support. The sprocket and chain drive of Rosenberger ('27) and Lewis ('29) for the synchronization of shutters, etc., can hardly be recommended unless entirely removed from the microscope and camera supports. The application of the synchronous motor operating on 60 cycle 110 volts is recommended, in fact motors of this type may be built in a small shop to produce any required r.p.m. within the range of the cycle. For critical time lapse work, constant speed is imperative and the synchronous motor should be used where 60 cycle alternating current is available.

Speed reduction units are obtainable in almost any ratio and the fractional horse power motors ranging from 1/16 to 1/200 meet every need. The most compact unit so far devised is that of the Bausch and Lomb Optical Company for their 16 mm. Ciné Kodak assembly. The variable speed reducer, driven by a 1/200 h.p. motor, is very efficiently designed. A detailed account of the various driving mechanisms would be duplicating results

already published and the interested reader is referred to the original papers. No part of an apparatus for motion photomicrography requires more attention and painstaking workmanship than the driving mechanism and the experience of other workers should be taken into consideration when planning a device.

LIGHT

The general use of incandescent bulbs for low power photomicrography, because of their convenience, has introduced numerous complications, the two main ones being chromatic defects and uneven illumination. Critical illumination is impossible wherever a spiral filament is introduced. Efforts have been made by several manufacturers to overcome these two defects but with barely appreciable results. The introduction of pressed lenses and diffusion screens serve but to decrease the efficiency of the light source. With a 16 mm. objective used to project an image and a standard condensing and cooling system the efficiency of any light source is reduced 94%, according to Gage. We can readily see that the diffusion of a light source, so commonly used at present, reduces the efficiency of the illuminant to a very low level. The ribbon filament Mazda bulb used in conjunction with an aspheric condenser is the most convenient and efficient type so far evolved though it has the fault of sagging after heating. It would therefore be poorly fitted to serve as an illuminant in an intermittent circuit. This light could be greatly improved by supporting the ribbon or modifying the shape so that a disc-shaped central portion could be supported by introducing a third support to prevent sagging. They usually burn out on the sides where the stress has been greatest. The Point o' lite illuminant is most efficient when d.c. is available. The resistors, etc., necessary when used on a.c., decrease their efficiency and are more expensive. Canti and Rosenberger have used this type, whereas Lewis, Patten, and Kramer have found the incandescent type adequate for low power time lapse work. The lighting assembly (Fig. 2a) of Patten and Kramer ('32) is a novel feature of their equipment, quite flexible and sufficient for most requirements. Direct current is an absolute necessity when using an arc and dark field work cannot be done with any other light source. The clock driven type is needed if uniform results are expected.

When we consider that Marey and his students used a heliostat

for the photography of small crustaceans, etc., and obtained good results, the worker of today, with several types of illuminants at his command, should not hesitate to set up an apparatus though the obstacles are many and not the least of them light.

INCUBATOR

For most work *in vitro* the preparation is kept at a constant temperature. The microscope with its specimen is placed within the incubator. To maintain the temperature at a constant level all controls should be extended through the box, so that it is not necessary to introduce the hands to make adjustments. This has been nicely accomplished by Patten and Kramer ('32). It has been suggested by Mr. Gey of this laboratory that in order to facilitate manipulation of the microscope and preparation that a heating element, thermo-regulator and fan be so combined as to flood the microscope with a gentle stream of air of the correct temperature. Such a device would be of inestimable value where microdissection work is being carried on. In such an arrangement there would be no box to encumber the worker. The apparatus could be conveniently set up about the microscope.

CONCLUSION

In the foregoing statements, the author has outlined the early history of motion photomicrography and indicated some of the salient features of different apparatuses that have been evolved and applied to biological problems. The construction and arrangement of several important features of such apparatus has been scanned with the idea of suggesting improvements over existing types. Fully realizing that no one arrangement can be of universal application, he has pointed out several features in each that appealed to his sense of fitness. Such a review is necessarily based on one's experience in the particular field discussed, and in no wise claims to completeness. For exact knowledge, the reader is referred to the appended bibliography.

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CLINICAL CINEMICROSCOPY*

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CINEMICROSCOPIC subjects of great interest to medical as well as lay audiences may easily be photographed by the physician who has at his disposal a good amateur motion picture camera, microscope, and projector.

With the projector light beam focused on the microscope substage mirror, ample illumination is obtained for cinemicroscopy. The revolving shutter of the projector is, of course, held open and

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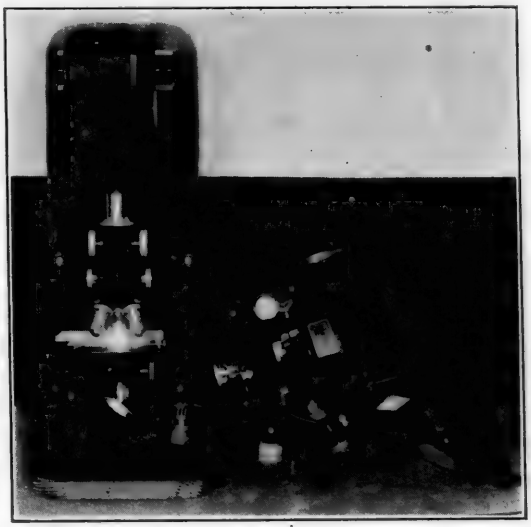
the fire shutter propped up. On projectors where the lamp has forced draft ventilation, a water cell in the light beam for cooling will be found unnecessary. The camera is held by a wooden support with its aperture centered above the microscope. The focusing mount of a large aperture lens serves as a light trap, and with a black paper slip tube mounted on the microscope barrel, provides a light tight connection between microscope and camera which does not transmit vibration. The microscope ocular is removed and another black paper tube is placed inside the microscope barrel to prevent reflections.



Focusing of the microscopic image is accomplished by sliding the paper connecting tube down on the microscope barrel, and shifting the camera laterally till the visual focusing device is centered above the microscope. A camera without the visual focusing device may be used if a small ground glass screen is attached to the side of the camera at the focal plane level.

Light intensity is governed by adjusting the microscope substage condenser, as cutting down the intensity of the light source with a rheostat introduces the unwanted chromatic factor of yellow light.

Regulations of the light intensity may be advantageously controlled by the use of a photometer which makes possible the taking of uniformly exposed shots regardless of the density of the specimen or the magnification used. The photometer is ordinarily used to measure the intensity of reflected light, and readings are made in terms of lens stops which will give proper exposure with that light.

For cinemicroscopy, the photometer is used to measure the intensity of the light projected upon a small glass screen held at

the focal plane level in the optical axis of the microscope. In the outfit employed, a ground glass screen was placed in the viewfinder barrel with its ground surface at the level of the aperture plate in a Bell and Howell Filmo camera. A horizontal metal slide or lateral shift device was used to center this screen, the aperture plate or the visual focusing device above the microscope.

To prepare the photometer for this type of work, an arbitrary scale was attached to the outer revolving segment with its zero at the arrow. Scale divisions numbered 1 to 20 were spaced to equal the distance between F stop divisions on the middle scale. After setting the middle slip-ring scale in the usual manner, moving the outer scale up past the arrow doubles the light intensity of the filament for each scale division. A series of short shots was then taken with recorded variations in light intensity as measured by the photometer on this scale. On projection of these shots, it was found that regular film required a light intensity of 10, panchromatic 8½, and panchromatic super-speed, 7. (Eastman film.) It was then found possible to secure properly exposed shots of any microscopic specimen regardless of its density or the magnification desired, merely by setting the photometer for the kind of film to be used, sharply focusing the microscopic image on the ground glass screen, and adjusting the brilliancy of the projected light to exactly match the brilliance of the photometer filament.

The photometer shutter speed scale may be used to calculate the light requirement for camera speeds faster or slower than normal. At least 64 frames per second is required to photograph the rapidly moving flagellates or motile bacteria, while 8 frames per second may be used to speed up the slow moving amoeba. Stop motion photography may be employed to speed up a time consuming microscopic reaction such as the agglutination of bacteria or blood cells in typing.

Yellow objects, such as blood cells in suspension or in the capillary circulation (frog mesentery), were found to photograph with more contrast and definition when a blue "dalite" glass filter was interposed in the light beam. Filtration with the regular yellow series of commercial photography was advantageous only when photographing polychrome stained blood smears or tissue sections.

This discussion of cinemicroscopy by an amateur, using amateur methods and equipment, is offered with the hope that it may stimulate the use of similar methods among teachers and research workers in the biological sciences, and thus provide a greater variety of teaching films for the future.

CINEMATOGRAPHY, ITS USE IN SURGERY*

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FOR THE past twenty years it has been my privilege to study various methods of teaching medical students. In surgery, much reliance is placed upon illustrations and surgical clinics to convey knowledge from the surgeon to the student. To this end, all medical schools use lantern slides, drawings, mannequins, models, etc., to aid in the clearer definition of subjects to be taught. Recognizing the eminent value of teaching by vision, the American College of Surgeons, associated with the Eastman Kodak Company, five years ago launched a definite, well-planned policy to establish a medical film library for use in the medical schools of this country. To date, several very excellent films have been completed and are now available for teaching purposes.

I believe that we are living in an age of motion. Surgery, in keeping with the general trend of events, is using the motion picture, both silent and sound, to record its progress. The experimental stage is in the background and the profession at large now recognizes the advantages offered to both the student and the physician through this medium of visual presentation.

The use of the 16 mm. camera has brought to every physician the possibility of making his own visual record of any case which he wishes to present either to students or to medical gatherings. Medical societies are now including motion pictures in their programs to illustrate various phases of medical progress. Indeed, it has been my experience to note that a good motion picture will elicit more interest than the average technical paper. At least, as a supplementary aid to any technical paper, it helps make the subject live.

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For undergraduate teaching, nothing can surpass the motion picture in demonstrating elementary facts. All the fundamental principles underlying surgical conditions must be stressed and clearly presented to the student, putting in the background the minute technical procedures leading up to the correction of pathological lesions. The animated cartoon type of motion picture gives the greatest opportunity to demonstrate fundamental facts.

CAMERA MOUNTED ON LADDER

Operative technique appeals to the trained surgeon who has already been thoroughly grounded in the elementary anatomical and basic principles. For the experienced surgeon, therefore, there is a splendid field for operating room motion pictures that show the technical approach of surgical procedures. This particular type of work should be encouraged to help the surgeon who has graduated and who is giving special study to his chosen field of endeavor.

We have been making our operative pictures in the operating room by use of the simplest kind of platform built out from a stepladder. It will be noted by reference to the illustration that this stepladder is brought alongside the operating room table and the camera is placed in a box provided for this purpose. A hole through the platform allows proper lens vision. An ordinary Anderson spotlight is attached under the platform so that the ray of light is parallel to the line of vision as seen through the lens of

the camera. All operating tables are equipped with an apparatus whereby the table may be raised or lowered and, in this manner, the proper distance from the camera may be obtained. We have used a portrait lens which, when attached to the regular f:1.9 camera lens, gives us a focal distance of two feet. In order to prevent delay, we have used two cameras so that, when one hundred feet of film is exhausted, one camera replaces the other. This eliminates delay, for it requires about five minutes to reload the camera with new film. Delay in any operative procedure should be prevented. Also, we have used a camera which can be hand cranked so as not to have to manipulate the spring in the usual type of amateur camera. In this way, operations progress without delay and, with this simple apparatus at hand, a surgeon can call in his equipment at any time to take a picture of any unusual operating conditions.

Motion pictures are not expected to enter in the field of surgical judgment. Surgical judgment is the sheet-anchor of the finished surgeon and can only come with experience at the bedside. But the making of amateur motion pictures in surgery offers a real field of usefulness to any physician who enjoys teaching. One of the traditions of the medical profession has been the desire to disseminate knowledge from teacher to student. The motion picture has opened a new field to further this great opportunity for scientific service.

APPARATUS FOR MAKING SURGICAL MOTION PICTURES*

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SOONER or later almost every medical school and some hospitals will be confronted with the problem of making motion pictures in the operating room. Whether the size be 16 mm. or 35 mm. the same question arises: what type of apparatus can we use in order to: First, keep the field sterile; second, keep from interfering

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with the surgeon or the progress of the operation in any way? With these factors in mind the Photographic Department at the Yale University School of Medicine designed a portable stand for making surgical motion pictures.

The apparatus consists of a steel stand four feet six inches (4′6″) in length and two feet (2′) wide, which is mounted on four ball bearing casters. The platform of the stand is about eight inches (8″) from the floor and has a wooden step arrangement enabling the operator to stand three feet (3′) from the floor. An extra portable step can be placed on the top step if necessary.

The first vertical section of the tripod arrangement rises five feet (5′) from the floor and the second section can be raised from six inches (6″) to three feet (3′) higher. A worm and gear system together with a steel cable is used for raising and lowering this section.

The upper portion of the stand consists of a frame one foot eight inches (1′8″) by two feet eight inches (2′8″). Across this frame is an adjustable cross bar on which the camera and lights are mounted. This cross bar can be moved up and down in the frame. The camera and the lighting arrangement can be moved from side to side on the cross bar. This entire frame can be adjusted by a crank system from upright to an angle of forty-five (45) degrees, thereby making it possible to place the camera almost directly over the operative field. A hand crank system on the camera is advisable so as to avoid the possibility of the spring running out during an important part of the operation.

Although this apparatus can be very easily moved around the operating room, it is best to find the spot where most of the operation can be photographed to the best advantage. For most operations this point is generally directly over the surgeon's right shoulder.

Often it is necessary to photograph the operation from another angle, and in such a case an extra camera can be used without a tripod. It is also possible, however, to use the same camera by adopting a simple system for detaching it from the stand without delay.

The regular operating room lights set at opposite angles to the camera and a 500-watt water-cooled spotlight placed directly in line with the camera provides an ideal lighting arrangement. It not only eliminates harsh shadows, but also makes it possible to stop the diaphragm down to F 8 on two-inch and three-inch lenses working six to seven feet from the subject. A non-welding, non-sparking switch for the spotlight must be specially constructed so as to avoid explosion when using ethylene gas as an anesthesia.

Supersensitive panchromatic film with and without a light yellow filter is used, but the film without the filter is sharper.

It is realized that this apparatus may not be practical for use in every operating room, and therefore alterations may be necessary to fit particular cases.

THE PHOTOELECTRIC EXPOSURE METER

AN INTERESTING development as an aid to the photographer in one of his most aggravating problems, correct exposure, is the photoelectric exposure meter, widely used in the field of cinematography and recently introduced for still camera work.

The Electrophot photoelectric exposure meter is composed of three principal units; a light-sensitive photo cell, an energizing battery, and a specially designed meter which translates directly into stop numbers the reaction of the photocell to the light which fall upon it.

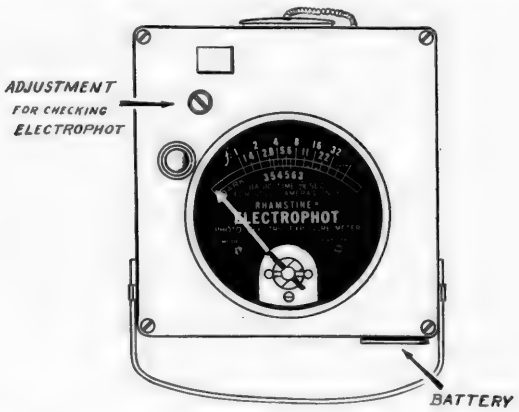
The photocell is of a flat, sealed grid type, protected by a plane lens making it dust proof and a plug cap which is removed to operate the meter.

The battery consists of two small cells of the "pencil flashlight" type and lasts over six months under normal operating conditions. The actual electric power required to deflect the dial needle is infinitesimal—about .0001 amp. maximum. These cells last as long as their "shelf life," i.e., if simply stored. (This amount of cur-

rent is but a very small fraction of that required to light the tiniest flashlight bulb.)

The graduated dial and the meter form the face of the instrument and are enclosed and protected under glass at all times.

To operate, the Electrophot is sighted at the scene or subject and the button near the dial when pressed provides the battery



contact which activates the dial needle of the vibrationless type. The instrument indicates the amount of light falling on the sensitive surface of the cell and translates it into terms of the U.S. or "f" stop markings, found on practically every amateur and professional lens.

The instrument is factory adjusted, but two definite adjustments are provided should they become necessary, one mechanical, the other electrical. The former is for the needle, the latter for the cell. Accuracy of reading is easily checked by testing it in a dark room with one ordinary 25-watt, inside-frosted bulb.

The complete Electrophot photoelectric exposure meter measures 4 inches square by 1 3/8 inches deep, the same size as a roll of film.

FIG. 1. A self-contained photographic illumination and camera stand, the "Surg-O-Ray," in use at Augustana Hospital, Chicago, by the inventor, L. E. Buschmann, collaborating with Drs. Kellogg and Nadeau. Five concentrated spotlamps, each containing a 50 c.p. automobile bulb behind moss-glass diffusers, furnish a soft, cool, and virtually shadowless operating light, that permits cinematography with normal speed panchromatic film at aperture of F 8. The lights are manipulated from the central gas-proof switch and resistance control (see right hand of cameraman). A Filmo 16 mm. movie camera is controlled and rewound from same position. A two-inch lens is focused to scale. Two special bull's-eye spotting lights indicate the photographic field, and control of the field is maintained by mirror mounted near camera head. The "Surg-O-Ray" can be adjusted to any required position.

If you are interested in becoming a member of the Biological Photographic Association, communicate with Mr. Ralph P. Creer, Department of Photography, School of Medicine, Yale University, New Haven, Connecticut. If you make biological photographs this organization and its journal will be indispensable to you as an aid in producing better photography.

FIG. 2. Another arrangement of low-voltage automobile spotlights giving sufficient light for making Kodacolor film. The Filmo camera is fastened to a metal ring, and centered with the "spot" from the bull's-eye of the regular "Operay" light. Lens focused to scale. Camera controlled with solenoid, tripped by assistant surgeon by means of a foot-switch in series with the auxiliary lamps. Additional light is on only while motion pictures are being made. As used at Jackson Clinic, Madison, Wis., by Dr. R. B. Stout.

THE JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION is desirous of presenting to its readers worth-while methods of producing biological photographs. Evidently you have developed, invented or perfected methods of doing things that are worthy of publication. If so, communicate with the editor at 519 W. Lombard Street, Baltimore, Maryland, sending him a description and illustration, if possible, of your accomplishment. It will be given prompt attention and consideration.

THE FILING OF PHOTOGRAPHIC PRINTS*

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WHEN books were gathered into libraries, it became necessary to have for them some systematic arrangement. As libraries grew, each developed a system and catalogue of its own. There were as many systems as there were libraries. To use a library one had to first learn its system. All was confusion until, in this country, a practically universally used cataloguing system (the Dewey decimal system) was developed. Working knowledge of this system unlocks all important libraries.

Business filing has not progressed to quite the degree of universal simplification that is found in our libraries, but there are several excellent closely related systems that are not difficult to master in changing from one office or business to another.

Files, catalogues, and index cards, making biological photographic records accurate, the material safe and readily accessible and which are universally applicable under the varying conditions and relationships to other departments in which we find ourselves, have not yet been devised. With the idea of finding out something about what others were doing, I sent out letters of inquiry. The generous number of replies received, the interest and coöperative spirit shown, has been most stimulating and instructive to me. It seems worth while that I share the information received with others. There is undoubtedly unity of purpose, but great divergence in methods. As in libraries, at the beginning, each institution seems to have worked out a system best suited to its particular needs. No one seems to have all the useful knowledge; none is without its good points and worthy of careful study.

In "Clinical Photography," Vol. VII, No. 3, June, 1931, Robert T. Morrison, of the Medical Division of the Eastman Kodak Co., writes most interestingly of the photographic department of the Minneapolis General Hospital. The entire article should be read, for it well describes the purpose and organization of this highly

* Received for publication June 24, 1932.

MEDICAL PHOTOGRAPH REQUEST

Patient's Name _____ Hospital No. _____ Station _____ Date _____

Region _____ Diagnosis _____

Physician's Name _____ Service _____

Remarks: _____

No. of Prints _____ No. of Lantern Slides _____

Miscellaneous Request _____

NO.

UNIVERSITY OF MARYLAND

REQUISITION FOR PHOTOGRAPHIC WORK

DEPARTMENT _____ DATE _____

Doctor _____ Surg. Path. No. _____

Patient's Name _____ Mic. Sli. No. _____

Address _____ Chart No. _____

Organ or Tissue _____ Autopsy No. _____

Photograph of _____ Disp. No. _____

Diagnosis _____ X-Ray No. _____

Do you want lantern slides? _____ Jour. _____

FIG. 1. Typical requisition cards. Filing cards contain practically the same data. The top card is used at the Minneapolis General Hospital.

developed service, unique in its way. Just as with all the rest of us, at Minneapolis the bulk of the material falls into two grand divisions—prints and lantern slides. Concerning the prints, Mr. Morrison writes as follows: "When a requisition is presented to the department, the patient's name, the date, etc., is recorded in

a journal from which the filing number is obtained. File cards are made out in triplicate, for cross indexing, and are catalogued as follows:

(A) By name of patient
(B) By diagnosis
(C) By region (or part)

After exposure and printing, the negative is placed in an envelope and filed by number. The print is mounted on a card and placed in the record room with the patient's history, thereby becoming a part of the case record."

Mr. Ralph P. Creer states that so many prints and lantern slides are made at the School of Medicine, at Yale, that the practice is for each department to do its own filing. He gives the department of pathology as an interesting example. "Each autopsy of importance is illustrated. The tissue blocks, stained sections, negatives, prints, photomicrographs, lantern slides, and drawings are filed separately, according to the autopsy number. The photographic prints are catalogued in the department office according to diagnosis."

Mr. Louis Schmidt has given me permission to describe the system for filing prints at the Rockefeller Institute for Medical Research with which system I am somewhat familiar.

All necessary data, including the file number, is written on a file card and then printed on the negative in "looking-glass" writing so it will read correctly on the finished print. These prints are then mounted in a book. On these books are written the inclusive dates they cover. Individuals desiring prints of a photograph made at some previous time are able to glance through the books, and, recognizing the prints, give the number to the photographer who produces additional prints. The cut film negatives are placed in transparent, waterproof envelopes and filed in steel cabinets. Plates, which are used for photomicrography entirely, are filed in similar envelopes on shelves.

File cards for the month are placed in a small file box. After a record is made of the charges to each department these cards are placed in the regular file. This method saves extensive bookkeeping.

From Mr. Carl D. Clarke, of the Department of Art and

Photography at the University of Maryland School of Medicine, I am quoting as follows: "When a case is referred to the photographic department we fill out a requisition card as completely as possible. After the picture is taken and developed we fill out a second card according to information on the requisition card. We then mount the picture on a large card containing the same information as the other two cards. The requisition is filed under the doctor's name; the second card is filed under 'Diagnosis.' The large card with the mounted photograph is filed in the photographic department. A notice is then sent to the physician who has ordered the photograph stating that it has been finished. The size of the card, on which the prints are dry-mounted, is ordinary file size 10½" x 12". This gives plenty of room for one 8" x 10" print or two 5" x 7" prints and number of smaller ones. At the time the picture is taken the department ordering the photograph lets us know if prints are desired at once for their filing system, the hospital history, or for publication. Otherwise the print on the card is held in this department. When needed, additional prints are ordered from the one on file in the photographic department. The negative file number is the same as the positive file number."

Miss Marion Rowell, at Peter Bent Brigham Hospital, at Boston, writes me as follows: "Each photograph is listed in a record book as soon as it is taken. Every case has its identifying photographic number—the same number being used for every view or kind of picture taken on a given case, regardless of the number of years that may intervene between the discharge and re-admission of the patient. The entry also includes full name of patient, pathological number, if any, brief description of the photograph, number of views taken and the date. In addition to the record book is an alphabetical name file of the patients photographed, and on this card an entry is made of each photograph taken. These cards are in the studio for ready reference. A print of each photograph is placed with the patient's chart. The patient's name, photo number, and date are written on the back of each print that is made. When the negatives are dry, the patient's name and pathological number are written on the bottom where they will not show in the print. The negatives are filed in manila

envelopes, with the number, name, remarks, and date recorded on the outside."

Miss Rowell finds it worth while to keep a file of extra prints, arranged alphabetically under the patient's name, of unusual cases. These are the prints most likely to be used as illustrations and called for in a hurry. She also keeps a duplicate file of the most interesting prints, according to disease classification. For example, her best "Glioma" pictures go under that heading. This file is very useful when illustrative material is needed.

Miss Grace MacMullen, located at the Babies Hospital in New York, writes that they send prints and lantern slides to the several departments for filing, but, of course, keep the negatives in file numerically, and a cross file, alphabetically, under the patient's name. The data, including the number, name, age, diagnosis, and date, is taken from a numerical file card and is written on the back of each print. Two prints are made from every negative. One copy is sent to the central record room and placed with the patient's chart. The other print goes to the pathology department and is filed alphabetically in a name file, with cross file according to diagnosis.

The system used at the College of Medicine at Syracuse University is as follows: A day book is kept, in which the pages are filed under the headings, number, date, doctor, private or department, name or number, specimen, work done and charge made. Each photograph taken, regardless of the specimen, is given a number and this number is written on the negative, print, and manila envelope, in which it is filed. The method of numbering films is as follows: The letter "P" (denoting Photography) is used before the last two numbers of the year—as P 32. The first picture made in 1932 is numbered P 32.I, and so on to the end of the year. At a glance one is able to tell in what year a specimen was photographed.

All films made on one subject, regardless of the time intervening, are filed in one envelope. A print of each negative is sent to the doctor who referred the case, and one is kept on file in the photographic department.

The day book aids greatly in summarizing the work done during the month and in making out bills and file cards.

Some other interesting things regarding prints have come to

my knowledge. At the Rockefeller Institute, and perhaps elsewhere, portraits of all the members of the various departments of the Institute are kept in a special file. The importance and interest of such a file, on occasion, will be easily understood.

Prints that are to be much handled in and out of files may be cloth-backed and sets made up in strip form and folded accordion fashion. This latter type of treatment would be especially useful for keeping related photographs together, for showing progressive stages of material under microscopic examination, and changes resulting during various stages of chemical experimentation. The cloth backed prints are flexible, yet firm, and will not curl or fray. By the use of the photo-cloth, prints mounted in book form, far exceed in beauty and utilitarian value, the antiquated scrapbook method.

Prints for exhibit or classroom demonstrations will last a long time under hard usage if mounted passe partout. Sometimes it would be interesting to put two prints, mounted in this way, back-to-back—such as right and left or front and back views.

Of no less interest to me is the information gleaned from the replies regarding the filing of lantern slides. Of this I shall have something to say in a later number.

CLINICAL PHOTOGRAPHY BY THE PHOTO-FLASH LAMP METHOD*

ARTHUR W. FUCHS
ROCHESTER, NEW YORK

From the Medical Division, Eastman Kodak Company.

CLINICAL records represent the *story* of the patient, undeleted and supplemented by thorough, searching investigation as to progress and treatment. They are a story of facts and as such, graphic evidence of them should be incorporated in the case record. Because a record contains elements of diagnosis and treatment, it should contain photographic confirmation of the diagnosis and the results of treatment wherever possible. The clinical case record library is a collection of knowledge and as a reference source should be replete with every item of information which will make

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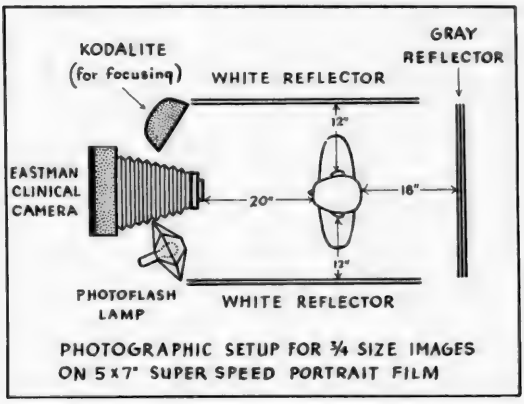

FIG. 1. Camera set-up for photoflash lamp photograph.

all case records thoroughly intelligent, indisputable, and withal comprehensive.

There is a certain pride manifested by most clinicians in the compilation of reliable case histories consisting of the narrative and pictorial description of disease. Such histories require that they be photographically illustrated. The manner of incorporating the photographs in the record is a matter for the hospital to decide with whatever aid is advanced by the American College of Surgeons, American College of Physicians, or the manufacturer of record forms. It is the duty of the maker of the clinical photograph to furnish only those of satisfactory quality and to the manufacturer of photographic materials to aid the art of clinical photography to the point where the ultimate photograph *tells the story.*

The most common type of clinical photograph is the close-up view in which lesions on or near the surface of the body are depicted. The prime requirement in such photographs is that the lesion be reproduced with practically microscopic detail in and about the lesion; there must be no "softness" or illusion, but instead, accuracy of structural delineation of the area of interest to definitely show its pathological nature. The best clinical photographs are those which tell the story in a coldly impersonal, scientific manner.

In order to secure images with the required detail and perspec-

tive, it is necessary that the camera lens be sharply focused and then "stopped down"—that is, the aperture must be small. And since the amount of light reaching the film is reduced when the size of the lens aperture is reduced, a proportionate increase in the exposure is necessary. This requirement has always presented a major difficulty in clinical photography because, in most cases, the patient is unwilling to coöperate or incapable of doing so in a manner that will satisfy this photographic limitation.

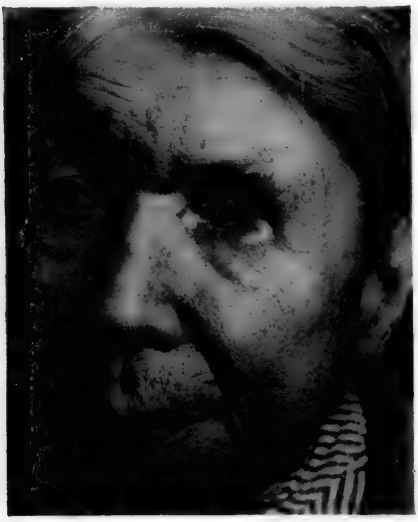

FIG. 2. *Eye tumor (cured).* Scale ¾. Note depth of focus.

As an illustration of this point, if a skin lesion such as a hemangioma on a lively baby's face is to be photographed *close-up,* a small aperture is necessary to obtain depth of focus. The photographer formerly had to use a long exposure. Obviously, the best quality photograph could not be made because it was practically a foregone conclusion that the patient would move during the exposure. Recent developments, however, have overcome this difficulty, and the photographer now can obtain an abundance of illumination in a very simple manner; all that is necessary is to use Mazda Photoflash lamps. The method of close-up clinical photography with this type of illumination is simplicity itself; anyone who can focus an image on a ground glass can make photographs of excellent quality. Standardization of

FIG. 3. *Xeroderma of Kaposi.* Scale ¾. Note detail in lesions.

close-up clinical photographic procedure becomes a reality with this new development.

The Mazda Photoflash lamp consists of an evacuated glass bulb within which is a piece of aluminum foil. When the lamp is connected to a flashlight battery, the foil is ignited by the current, creating an instantaneous blue-white light of uniform intensity, which assures a uniform exposure. There is no flame, smoke, noise, or fumes, nor any more hazard than when using an ordinary electric lamp. The flash of light is of such short duration that most patients are barely aware of it, and even the nervous patient has no opportunity to react in such a way that the eyes would close or the position of the body change while the photograph is being made.

FIG. 4. *Elastic skin.* Scale ¾.

FIG. 5. *Lichen planus.* Shows general distribution of lesions. Scale ⅛.

As stated before, clinical photographs should have microscopic detail. In addition, it is advisable that they be made to a definite scale so the size of the area of the lesion will be identical in all photographs that are made of the case. By means of a focusing scale usually found on the bed of the clinical camera, this is easy to accomplish because all that is necessary is to set the film-holder compartment at the desired scale indication and so place the tripod in relation to the object that the image will be in sharp focus on the ground glass.

The camera bellows should have a draw of at least twice the

focal length of the lens so that objects may be photographed actual size, if required. The lens should be a high grade anastigmat approximately F. 7.7, and have an 8 inch focal lengtn.

In practice, the three-quarter size image made on 5″ x 7″ super speed safety portrait film has been found most suitable for medical photography, since the bulk of the work is essentially close-up, requiring the greatest amount of detail in the area of interest. It might be added here that in conjunction with close-up views showing the skin diseases, it is always advisable to make an additional photograph showing the general distribution and extent of the lesions.

The equipment and materials necessary for successful clinical photography with the photoflash lamp do not require a large investment. A list of the essential articles is given below.

1. A clinical camera.
2. Two home portrait reflectors (white, portable).
3. One home portrait reflector (portable) painted with a coat of light gray, to be used as a background.
4. A photoflash lamp reflector.
5. An adequate supply of Mazda Photoflash lamps.
6. Super speed safety portrait film.
7. A chair, preferably with an adjustable head-rest.
8. An auxiliary light for focusing.

PHOTOGRAPHIC SET-UP

A description of the method employed for photographing a *facial* lesion will serve to illustrate the general procedure followed in routine close-up photoflash photography.

The patient is seated in a chair with the head adequately supported by a head-rest so that the position does not change after the camera is focused. A white reflector is placed on each side of the patient's head, at a distance of about 12 inches. The gray background is located 18 inches or more behind the patient. An auxiliary light is placed so as to provide the necessary illumination *for focusing the lesion* on the ground glass.

The camera is adjusted so that the lens is on a level with the lesion. The shutter and diaphragm are opened, and the auxiliary light switched on. When focusing has been completed, the auxiliary light is switched off because it is not needed in making the exposure, the photoflash lamp alone being used for that purpose. The diaphragm is closed to F. 32 or F. 45 depending upon the

color of the skin or lesion; the shutter is closed; the film-holder containing super speed *safety* portrait film is placed in the film-holder compartment, and the slide removed. Finally, the shutter is opened and the photoflash lamp pointed at the lesion so that an angle of 45° is formed; it is held at the edge of the white reflector which is positioned on the same side of the face as the lesion, and above and slightly behind the camera lens. (The light from the lamp should never be directed into the lens.) The distance from the lamp to the object will be found to be approximately 30 inches. When the battery switch is pressed, the exposure is made. To complete the procedure, it is only necessary to close the shutter and replace the slide in the holder.

To photograph a case of skin disease, such as *lichen planus*, for the case record, a number of things must be taken into consideration. The photographs must be made to show: the generalized bodily distribution of the disease, the general appearance of one or more regions under treatment, and the detailed surface appearance of the eruptions.

In a case of *lichen planus*, the following procedure was adopted. A photograph of the back was made employing an aperture of F. 32, and an exposure obtained by two photoflash lamps suitably mounted in a reflector, Fig. 5. The result showed the general distribution of the disease over the back. A close-up showed the eruptions on the forearm in great detail. To show the detailed structure of the eruptions on the back, a photograph was made employing the following factors: full scale; aperture F. 32, exposure from one photoflash lamp.

Processing and Printing

It is not safe to handle photographic films in the processing room light ordinarily considered safe for x-ray films, so before loading or unloading film-holders, the Series 2 (red) safelight should be substituted in the safelight lamps if the Series 6-A (yellow-green) safelight happens to be routinely employed for the handling of x-ray film.

For convenience in processing a 5″ x 7″ or larger film, developing hangers (professional) should be used, as they hold the films flat and eliminate buckling or curling. The film should be developed for *8 minutes* in x-ray developer solution at 65° F.

Thorough rinsing, fixation for 15 minutes, washing for 30 minutes in circulating water, and proper drying complete the processing procedure.

Glossy Velox paper will provide the highest quality prints containing all the detail that was recorded in the negative.

If the photographs are to be prepared for exhibition, it is best to show them as transparent positive prints mounted in convenient cardboard mounts. When suitably mounted and placed before an illuminator, the demonstration is exceptionally effective because all the recorded detail will show with great brilliance. To protect these positives from abrasion and finger marks, a piece of cellulose acetate sheeting, .0075 inches in thickness, may be placed in the mount next to the dull (emulsion) side of the print.

Transparent positives are made by printing the original negative on process *safety* film in the same manner as paper prints are made, with a small printer. However, there is one precaution that must be observed in this procedure: be sure to switch off the ruby lamp in the printer before placing the process film on the negative, otherwise, it may become light-fogged. When the ruby lamp has been switched off, place the process film with the emulsion side on the dull side of the negative. A short exposure, depending upon the density of the negative, is all that is required. The processing is the same as was described for the negative—8 minutes' development at 65° F. in x-ray developer solution, rinsing, fixing, washing and drying.

With the certainty of high quality results brought to clinical recording by employing the photoflash lamp method, there should be no question as to the advisability of making clinical photographs as a routine measure. The inexperienced as well as the experienced photographer can produce satisfactory results easily and quickly. The photographic quality that will be obtained is something that heretofore was deemed impossible even when using expensive lighting equipment. Such photographs provide invaluable records.

PHOTOMICROGRAPHY VERSUS VIBRATION*

H. W. ZIELER
NEW YORK, N.Y.

From *E. Leitz, Inc.*

THE prospective photomicrographer will always be inclined to select optical equipment of the highest correction and expects to obtain with it pictures of maximum sharpness at all magnifications. Yet photomicrographs, especially at high magnifications, often lack sharpness in spite of good optical equipment.

In every photomicrographic apparatus the microscope and the camera must necessarily constitute separate units. Vibrations from the floor or support of the apparatus are transmitted to the microscope and to the camera, and cause them to swing in different phases and periods depending upon the mass of each unit. Consequently the image on the ground glass vibrates and the negative lacks sharpness.

In selecting a good photomicrographic apparatus, it is therefore necessary to also pay attention to an effective vibration-absorbing device. Only in exceptional cases will it be possible to install the apparatus in a room which is entirely free from vibrations. Several photomicrographers have tried to eliminate vibrations by supporting the base of the equipment on coiled springs or rubber cushions. Vibrations may thus be more evenly distributed over the entire equipment, but they are not sufficiently eliminated to guarantee success for high power work.

The comparatively long and narrow optical bench with the saddle stands comprising the equipment has its gravity center above the base. Support on coils therefore makes the entire unit respond too easily to vibrations; for similar reasons a ship with a heavy deck load rolls considerably from the most minute causes.

The effects of vibrations can be practically eliminated by counter-balancing the heavy parts above the optical bench with a heavy weight below the optical bench and by suspending the entire unit from the base. An additional movable weight running along a rail may serve for the compensation of variations in the position of the camera. Thus the entire apparatus rests in a state of rigid equilibrium.

* Received for publication July 12, 1932.

ARRANGEMENT FOR A PROCESSING ROOM OF LIMITED SPACE*

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BALTIMORE, MD.

From the Art Dept., School of Medicine, University of Maryland.

UNFORTUNATELY, many photographic departments in institutions such as hospitals, medical and dental schools are placed in rather cramped quarters. It is often the case that these departments have such little space in which to carry on their endeavors that from the very beginning they are handicapped.

On the other hand it must be realized that the photographic department is generally a comparatively new addition to the average institution. It must therefore be placed in the space that is convenient to use, if not entirely suitable. In too many institutions such a department is considered a luxury rather than a necessity. They eventually find that a photographic department is a necessity, however, for their continued advancement. Schools of today are generally rated by what they produce. The number and quality of articles published in their professional journals play a great part in creating their reputation. These articles have to be illustrated, and that is one way in which the photographer becomes a necessity.

Much could be said on the value of the photographic department, but this article is to be limited to using the available processing room space to the best advantage considering the amount and variety of work to be done.

Many institutions are undertaking to make the following types of photographs: clinical and gross pictures, photomicrographs, cinematographs, cinemicrographs and radiographs.

The accompanying diagrams show the layout of the single processing room of the photographic department of the School of Medicine of the University of Maryland. In this processing room are developed negatives and positives made in still cameras, photomicrographic cameras, motion picture cameras, and pictures made with an x-ray apparatus used entirely for animal experimental and research work. Considering this variation of work much effort

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was spent in designing this processing room with the idea in mind of standardization of processes and utilization of space.

Figure 1 is a diagram of the layout of one wall which is only nine feet four inches wide. Considering this layout from the top down there are two shelves for chemicals, etc. On the second

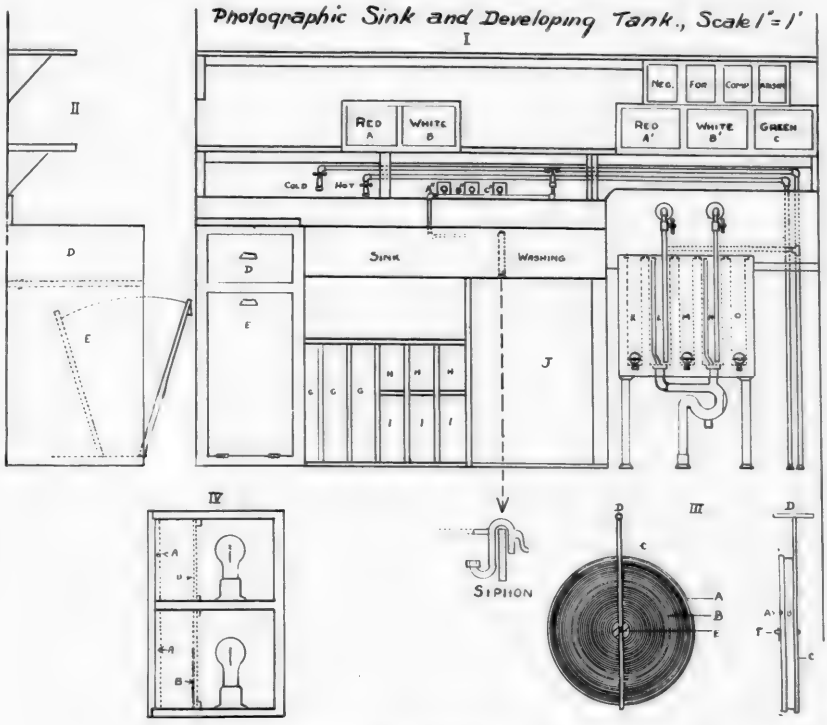

FIG. 1. Scale reduced to 1/3.

shelf from the top is a double light box A and B, containing a white light and a red safe light. To the right of these light boxes are three other light boxes, A′, B′ and C, containing red and green safe lights, also a white light for viewing films or plates after they have been removed from the hypo. Of course the red lights are for developing ortho and commercial films and plates, while the green light is for developing panchromatic films and plates. Above these three light boxes is a single light box containing four negatives for comparison in developing. Of course these are supposed to be perfectly exposed and developed. One

is the negative of a clinical picture, another is of a pathological specimen, the third is a photomicrograph, and the fourth is of a line drawing. These negatives are all 5 x 7 inches in size. Under the boxes to the left is a hot and cold water spigot. To the right of these spigots are three electrical switches for controlling the light boxes. Both white light boxes and the box above for comparison of negatives turn on with the center switch marked B″. Both red lights turn on with the switch to the left marked A″. C″ controls the green light box marked C.

Under the light boxes marked A and B is the sink proper. This sink is divided into two compartments, the part to the right being used for washing. The siphon keeps the water in constant circulation.

To the left of the sink is a drawer marked D which is used for a thermometer, stirring rod, and other small apparatus. Under this drawer is a bin which holds about 150 pounds of hypo. The space under the sink is used for funnels, graduates, and mixing containers. Under this space is a section divided for holding developing trays. The part marked GGG holds three 15 x 18 trays, HHH holds three 7 x 9 trays, and III holds three 10 x 12 trays. The open space marked J is suitable for a large trash basket. To the right of J is a stone tank, the outside dimensions of which are 24 inches long, 20 inches wide, and 21½ inches deep. This tank has two compartments, L and N, that are used for running water. These compartments are 4 inches wide, 17 inches long, and 20 inches deep. In this tank are also three compartments, K, M, and O, which are 2½ inches wide, 17 inches long, and 20 inches deep. These compartments hold approximately three gallons each. O is devoted to a contrasty, metol-hydroquinone developer, M to a normal metol-hydroquinone developer. The section marked K is used for the hypo fixing bath. All negatives are developed in one of these two developers or both, depending on the effect desired. This includes clinical and gross pictures, photomicrographs, line drawings or charts photographed with process plates; motion picture negatives and positives; and radiographs. The developer in compartment M is a developer for motion picture film but is excellent for the average clinical or gross picture. The developer in O is an x-ray developer which is ordinarily contrasty. Not only are radiographs developed in this compartment but also motion picture titles.

All motion picture film is wound on a Steinman reel or rack and placed on a specially designed holder as is shown in Part III. This holder and reel fit in any compartment of the tank and develop 100 feet of film in a perfectly even manner. To insure this the reel is rotated at intervals while it is still in the developer. The upright metal rod marked C in Part III prevents the film from coming off the holder. In Part III the Steinman rack is marked A and the motion picture film is marked B. Due to the fact that it is often necessary to make an unlimited number of tests in cinemicrography and the necessity of knowing at once if the negative is a failure or a success in clinical photography, it is very desirable for the biological photographer to be able to develop his own motion picture film. The element of waiting hours and days is eliminated.

It is not always advisable to print and develop the positive, as the negative and positive should go through the polishing process and other refinements that are easily handled by commercial laboratories; but it is entirely possible to develop positives, as well as negatives, with the equipment described above. In this dark room that is being described is a motion picture printer used to print the positive. Thirty-five millimeter film is used entirely for all cinematography done at the School of Medicine, University of Maryland.

In Part III, C is the metal rod that holds the Steinman reel. The film B fits against this rod, thereby keeping the film from slipping off the reel A. The cross-piece D keeps the reel suspended in the developer. The projection or pivot at E holds the reel to the rod.

Cut films 4″ x 5″ or smaller are developed in this tank mounted on Eastman film hangers. These film hangers ordinarily take a dozen films at a time but for this tank one film hanger has been cut in four parts and a metal support added to each of the four parts. In this manner we have four individual film hangers to fit the tank, each hanger accommodating three films.

Part IV is a diagram of the cross section of the light boxes on the right. The top one is used for holding the negatives for comparison. The negative is marked A, B is ground glass. In the lower section A′ is the colored safe light, B is ground glass.

In Figure 2 we have the apparatus that occupies another wall of the dark room which is about 12 feet in length. To the left

is a table, Part I, the center of which is used as a photographic printer. This printer is large enough to take a 14″ x 17″ x-ray negative. The bulb marked A is red and is used as a guide light. In this printer there are four 100-watt frosted bulbs that are used as printing lights. Two of these bulbs are marked B. The guide light A is controlled by the switch marked C, while the printing lights marked B are controlled by the switch marked D.

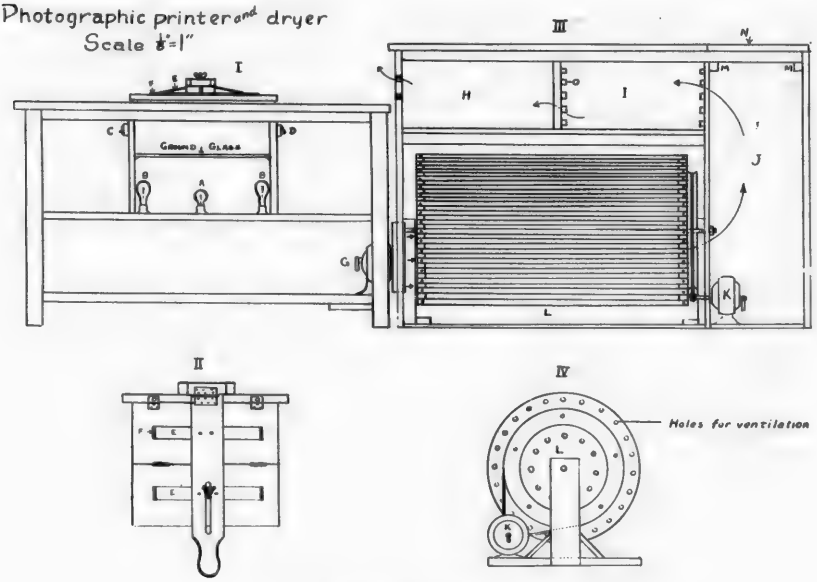

FIG. 2. Scale reduced to 4/13.

The lid or top of this printing compartment is surfaced with heavy felt to create absolute contact. Attached to the handle of the lid are two pieces of bent steel marked E. These steel pieces give a spring effect in pressing down and slide on other flat steel pieces marked F; this helps to give contact. Part III gives another view of this lid.

The large apparatus at the right, Part III, is a drying compartment for films, plates, lantern slides, motion picture film, and glossy prints. There is an electric fan at G which blows through the large wooden frame cylinder L used for drying motion picture film. This cylinder is constantly revolved by the motor K, while the film is drying. This cylinder holds a little over a hundred feet of 35 mm. film. In this manner 100 feet

of film can be drying while other motion picture films are being developed or washed.

The compartment J is used to dry cut films and plates which are suspended from supports at the top marked M. The lid N to this compartment is on hinges in the back and lifts up. The compartment I is used for drying glossy prints mounted on ferro type tins. This compartment holds six 18″ x 24″ tins. Compart-

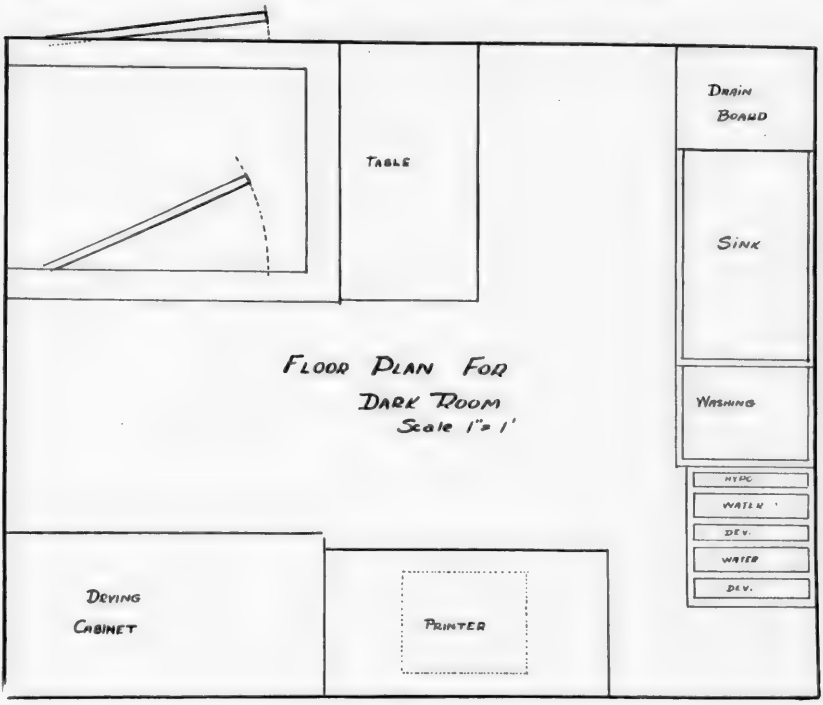

FIG. 3

ment H is used for drying lantern slides mounted on racks holding twenty-four slides each. This compartment can hold five of these racks.

Of course doors fit over the entire compartment keeping the air circulating in the direction indicated by the arrows.

Below this compartment is a diagram of an end view of the motion picture film cylinder marked IV.

When the fan and revolving cylinder are in motion film can be dried in eight minutes without the aid of a heater, but for motion picture film this is entirely too fast, causing the film to

become too dry, which leads towards brittleness. It is best to dry motion picture film without the aid of the fan. When the fan is not used the film will dry in about twenty minutes with the cylinder revolving.

In Figure 3 we have the layout of the entire floor plan of the dark room.

The overhead lighting consists of a direct white and red light, also an indirect light box containing red and green lights. The dark room is ventilated by a large suction fan that draws air out of the room through a light tight opening in the wall.

It is admitted that this dark room is indeed crowded. A separate dark room from the one used for developing negatives that can be used for printing would be a superior plan, but as mentioned in the beginning of this article, space is not always available. The outcome of the situation is that we should make the best of what we have.

MORGANA COLOR PROCESS

FILMO cameras and projectors designed for taking and showing color motion pictures by the Morgana Color Process are announced by the Bell and Howell Company. This company states that it considers Morgana the best two-color additive process that has appeared.

In this process color is not inherent in the film itself but is obtained by special filters in the camera and projector in conjunction with special mechanism. Different types of mechanism are employed in the camera and projector respectively, the projector mechanism embodying a radically new principle never before applied to motion picture technique. It is this unique projector mechanism that is largely responsible for the outstanding results obtained, which include a total absence of the flicker which has heretofore seldom been dissociated from two-color additive processes.

The Morgana Color Process was invented by Lady Williams of Pontyclum, South Wales.

The Morgana Process, we are informed, does not parallel the advantages of three color systems, but has these major distinguishing features: (1) Regular panchromatic reversal film is used. (2) Duplicates may be made just as from panchromatic reversal film exposed for black and white movies. (3) Any Filmo lens may be used. The filters in the camera are behind the lens seat. (4) Pictures may be taken under adverse light conditions. Merely open the lens one stop to allow for the two-color filters. (5) Screen pictures 10 feet wide may be shown with a Filmo projector.

The Bell and Howell Company states: "The disadvantages of the Morgana Process are less than those of any other two-color additive process. Color rendition, while not so faithful as by a three-color process, is nevertheless very pleasing and artistic. Slight fringing is prevalent with close-ups in fast motion, but is not considered objectionable. In any consideration of this process we must, of course, keep in mind its indubitable advantages of great photographic latitude, large screen images, and duplicate prints."

DEVELOPMENT OF THE CAMERA OBSCURA*

CARL D. CLARKE
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From the Department of Art and Photography, School of Medicine, University of Maryland.

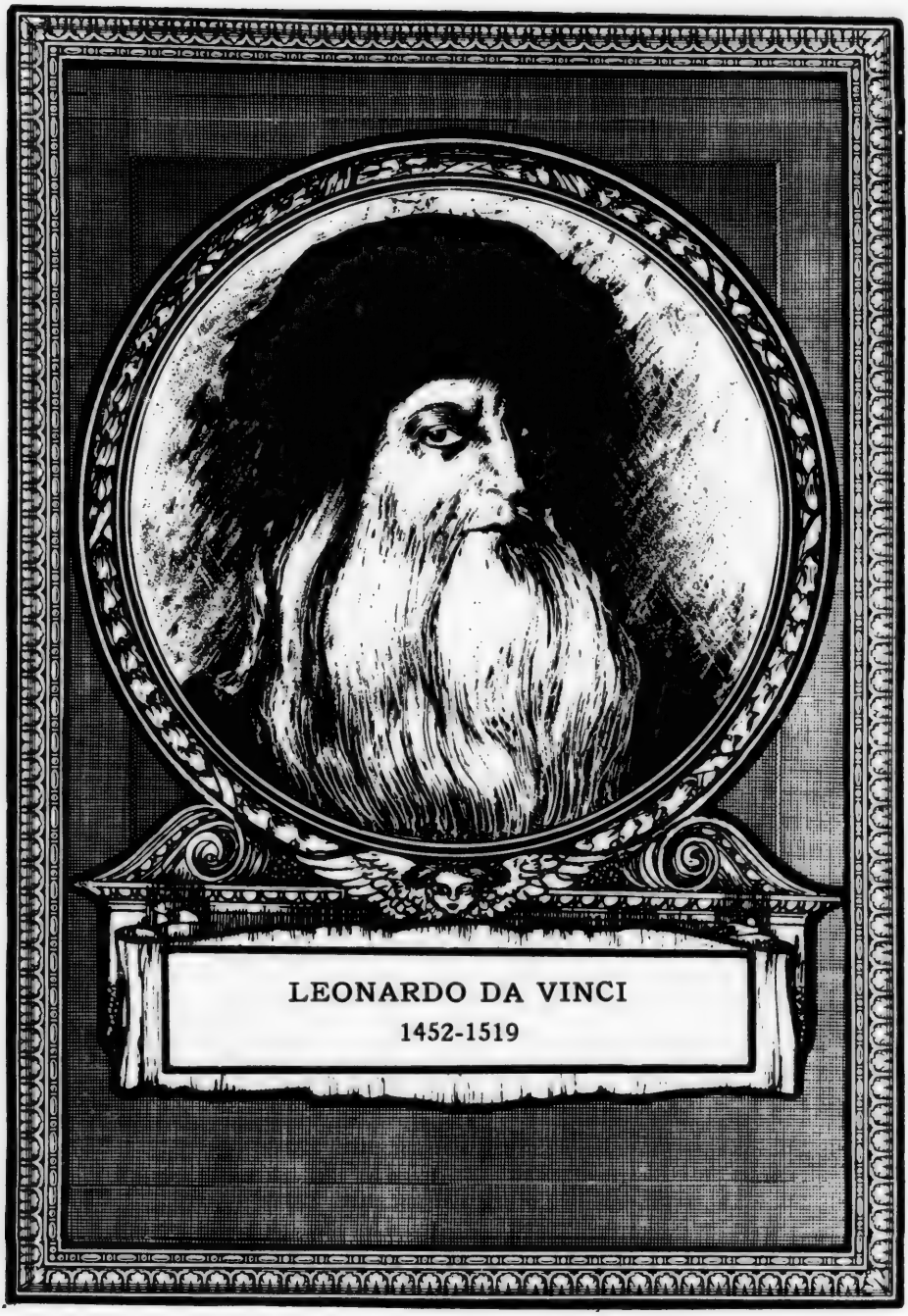
PHOTOGRAPHY is the art and science of producing permanent pictures by means of the chemical action of light on sensitized surfaces, such as glass, celluloid, paper, etc. The word photography was probably originated by Sir John Herschell. It is derived from the two Greek words (φῶς light, γραφία write) meaning to draw by light.

Many individuals have claimed to be the originator of this idea but as in other processes it is hard to attribute it to any one man. Photography is the child of optics and chemistry. Due to lack of development at the time of these studies it is not surprising to realize that the ancients knew nothing of making photographs.

A photographic camera is an apparatus consisting mainly of a lens, a bellows or box, and a back suitable for holding a sensitized photographic plate or film.

Camera is a Latin word originally meaning an enclosure with a vaulted or arched cover, but in the course of time came to mean a room. Thus, the *camera obscura* means a dark room except for the small opening which serves as a lens. The camera obscura as we know it today is an optical instrument used to view or sketch objects at a short distance. It consists mainly of a rectangular box formed of two parts sliding in each other, similar to the joints of a telescope, so as to adjust the focus to bodies more or less distant. A tube with a lens is fixed in one side and is directed towards the object to be represented. The rays entering the box through the lens fall on a mirror sloped at an angle of 45°, which directs them through a horizontal plate of glass in the top of the box upwards to the observer's eye. A piece of tracing paper may be placed on the glass and one may draw or trace the picture that enters through the lens. A lid to the box, or shield, is used to rid the observer of superfluous light. The Graflex camera operates on this principle.

* Received for publication April 5, 1932.



LEONARDO DA VINCI

1452-1519

After the invention of the *camera obscura* in smaller than room size a lens and a rack for holding a sensitized plate was added. Soon the word *obscura* was dropped, leaving the word *camera* as we know it today.

The physics of producing such pictures is as follows: Rays of light coming from the object to be photographed strike the lens of the camera where they are bent by the lens and brought to focus on the sensitized substance. These rays create an image on the substance which can only be seen after chemical development. This image is called a negative, its black and white tones being opposite to the tones of the subject photographed. By placing the negative in contact with a sheet of sensitized paper, glass, or metal before a light source, a *positive image* is obtained wherein the tones are reversed back to represent the modeling, form and composition of the original subject. These positive images can also be obtained from the *negative* by photographing the negative or by projecting the negative upon a sensitized substance and chemically developing this substance.

There is some dispute as to the invention of the camera obscura, as well as the date it was invented. On the other hand, we can hardly call it an invention because it is practically no more than a natural phenomenon that must have been observed quite often without creating any profound interest. At last some more enterprising individuals began to set down in writing their observations of this natural phenomenon and tried to find its cause and practical applications.

Aristotle in his *Problemata,* published about 350 B.C., refers to the fact that the image of the sun formed by the rays of light passing through a square aperture appears circular. He made notes as to the amplification of the image as the distance from the aperture is increased. Aristotle was unimpressed by these facts and missed discovering the camera obscura entirely and, properly speaking, has no place in its history.

From the time of Aristotle in 350 B.C. there seems to be no mention of the physics of the camera obscura until the tenth century. At this time the Arabian mathematician and philosopher, Alhazen, in his *Thesaurus Opticae,* which was not published until 1572, seems to have been more or less familiar with its principle, although he does not mention it specifically.

In Roger Bacon's *Perspectiva,* which was published in 1267,

he has a passage which many have taken for a first description of the camera obscura. The description is so indefinite that it might just as well be applied to the projection of images.

In passages of his *Opus Majus,* Bacon seems to also indicate a knowledge of the principles of the camera obscura but these terms also are so vague that we can hardly justify ourselves in crediting him with its discovery.

Leonardo da Vinci, who was born in 1452 and died in 1519, seems to have written the first precise and complete account of the camera obscura. It is to be found in one of his manuscripts that was never published during his life-time. Venturi in his *Essai sur les Ouvrages physicomathematiques de Leonardo da Vinci,* which was published at Paris in 1797, gives the following translation of the passage in the works of Leonardo:

> The following experiment shows how objects send their images to intersect on the albiginous humor inside the eye. When the images of illuminated objects enter into a very dark chamber by a small round aperture, if you receive the images in the interior of the room on a piece of white paper placed at some distance from the aperture, you will notice on the paper all the objects in their proper forms and colors: they will be lessened in size and will be reversed, and that in virtue of the intersection already noticed. If the images come from a place lit by the sun, they will appear as if painted on the paper, which should be very thin and looked at from behind. The aperture should be made in a very thin piece of sheet iron.

Accompanying this passage, Leonardo gives a diagram showing the arrangement of the aperture, screen, and the course of the light rays. He does not refer in any way to this apparatus as an invention which leads one to believe that he was not sure of being the first one to give its description. Whether he was first or not we do not know, but his description seems to be about the only one that has been handed down to posterity in as complete and understandable form as he has given.

Cæsariano, in his translation of Vitruvivin's *Treatise on Architecture,* published at Como in 1521, has a passage that credits the discovery of the camera obscura to a Benedictine Monk by the name of Don Papuito. Libri, in his *Historie des sciences mathematiques en Italie,* which was published at Paris in 1841, says that although this is the first published description of the camera obscura, the observations of Leonardo must certainly have been made at an earlier date.

An eminent mathematician of Messena named Maurolycus, in

his *Photismi de Lumini et umbra ad Perspectivam et radiorum uncedentiam facientia,* which was finished in 1521 but not published until 1611, treats this subject of light action mathematically. He also gives several theorems relating to the passage of light through small apertures and was apparently well acquainted with the formation of images in this way.

Erasmus Reinhold and his pupils Gemma Frisius and others probably used the camera obscura in Germany as early as 1540 to observe the eclipses of the sun without danger to their eyes.

Many authors of histories of photography, among whom are W. Jerome Harrison, have attributed the invention of the camera obscura to the Italian philosopher, Jean Baptiste Porta. There is a passage in his *Magia Naturalis,* a remarkable work which was published at Naples in 1553 when Porta was only fifteen years of age, that gives an accurate description of the apparatus. The misconception in accrediting Porta as its inventor probably arose from the fact that Arago, the eminent secretary of the French Academy of Sciences, in his address before that body on the occasion of the presentation of the details of the Daguerreotype process, took the liberty to make a few remarks as to the history of the subject in which he referred to the work of Porta in relation to the camera obscura. Arago did not distinctly give credit to Porta as the inventor, yet the eminence of the speaker established in the popular mind that Porta was the inventor. Evidently Arago had not delved thoroughly into an investigation of his subject. It is interesting to know that Libri, who was a colleague of Arago, in his work on the history of the mathematical sciences in Italy, which has already been referred to, called attention to Leonardo and others who had preceded Porta in making observations in relation to the camera obscura. Apparently this work never reached the photographic fraternity because for a number of years many writers of textbooks constantly referred to Porta as the inventor of the camera obscura. It was not until the appearance of Dr. Eden's *Geschichte der Photographie* and the work of Waterhouse that the photographic world realized the importance played by the predecessors of Porta in the development of the camera obscura. Nevertheless Porta did play an important part in the development of photography, though not near so great as he is often given credit for.

The first definite description of a camera obscura being fitted

with a lens is found in a work on perspective called *La Pratica della Prospectiva,* which was written by a Venetian nobleman named Daniella Barbaro and published at Naples in 1568. In 1585, which was seventeen years after the appearance of the work of Barbaro and four years before the appearance of Porta's second edition of *Magia Naturalis* in which is the description of the camera obscura with a lens, another Venetian nobleman named Giovanni Battista Beneditti wrote a book on mathematical and physical observations which was published at Turin, and refers to the camera obscura with lens. These lenses were plano convex in form.

Harrison says that Porta improved the primitive camera obscura by placing a double convex glass lens in the aperture outside of which a mirror was placed to receive the rays of light and reflect them through the lens. The image upon the screen within was in a natural or erect position and moreover was made bright and distinct. Crowds flocked to Porta's house in Venice to see these pictures painted by light. They were glowing with color and depicted with marvelous accuracy. It was not long before further improvements were made and the camera obscura became of favorite interest to the country houses of the wealthy. This apparatus often took the form of a small circular building erected if possible on a hilltop. The lens was usually placed in the center of a conical roof with a slanting mirror placed so as to reflect the light from the surrounding objects through the lens to the white surface of a table top that was placed within the little building. These camera obscuras of a few years ago were often placed in outdoor resorts. Those that gained admittance watched the actions of unsuspecting outsiders with interest and sometimes glee.

Persons expounding on the early visions of photography often let their imaginations run rampant, yet some of these visions became prophecy. It can hardly be believed that any of them could be so rash as hint that some day people would see pictures in color in which the subjects would move and speak.

There is a Chinese tradition that credits the sun with the power to produce pictures of neighboring objects on ice-covered lakes and rivers.

Fénélon must have possessed a similar vision when, in 1690, he wrote his fable called *Une Voyage Supposé,* which describes

the imaginary journeys of an imaginary personage. In this story there appears the following passage:

> There was no painter in that country; but if anybody wished to have the portrait of a friend, of a picture, a beautiful landscape, or of any other object, water was placed in great basins of gold or silver, and the object desired to be painted was placed in front of that water. After a while the water froze and became a glass mirror, on which an ineffaceable image remained.

In 1760 another Frenchman named Tiphaigne de la Roche wrote a book entitled *Giphantie* (an anagram of his own name) containing a series of wild imaginings. One of these must have appeared especially improbable to his contemporaries. This was indeed a still nearer guess as to the manner in which "nature painted" pictures would someday be produced than the guess made by Fénélon.

The hero of *Giphantie* is carried by a hurricane to a strange land where he is shown by the native genii the method of producing pictures. An extract from this part of the book is as follows:

> "You know," said the guide, "that rays of light reflected from different bodies form pictures, paint the image reflected on all polished surfaces, for example, on the retina of the eye, on water, and on glass. The spirits have sought to fix these fleeting images; they have made a subtle matter by means of which a picture is formed in the twinkling of an eye. They coat a piece of canvas with this matter, and place it in front of the object to be taken. The first effect of this cloth is similar to that of a mirror, but by means of its viscous nature the prepared canvas, as is not the case with the mirror, retains a fac-simile of the image. The mirror represents images faithfully, but retains none; our canvas reflects them no less faithfully, but retains them all. This impression of the image is instantaneous. The canvas is then removed and deposited in a dark place. An hour later the impression is dry, and you have a picture the more precious in that no art can imitate its truthfulness."

This guess or prophesy, as we choose to call it, undoubtedly came to pass, as is proved by modern photography. The idea is advanced that most likely De la Roche conceived of this part of his story after viewing the pictures shown in one of the house-like camera obscuras that were in vogue at the time. It strengthens the old axiom of "coming events cast their shadows before them."

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OPEN FORUM

SIR:

Recently, in the Crear Library, I read an article on time-lapse cinematography. Unfortunately this article did not give me as complete information as I desire. I should like to build such an equipment for use with 16 mm. film. Can you give me information as to where I can obtain detailed instruction about the building of such an apparatus?

Yours truly,

F. M. CONFER

DEAR MR. CONFER:

Dr. Warren Louis, of the Carnegie Institute of Embryology, and Mr. Heinz Rosenberger, of the Rockefeller Institute for Medical Research, have done quite a lot of work on time-lapse cinematography. I am sure that they have published articles on the subject and will volunteer information as to the journal in which these articles were published.

Bausch and Lomb Optical Company of Rochester, New York, manufacture an apparatus for making 16 mm. time-lapse motion pictures.

In the first issue of the JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION will be an article on this subject.

Very respectfully yours,

JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

BOOK REVIEWS

Photography, Its Principles and Practice. C. B. Neblette, F.R.P.S. Second Edition. 615 pages, 205 illustrations and diagrams. Price, $6.50. New York: D. Van Nostrand Company, Inc.

This excellent book, which stands prominent among text books of photography, is of considerable importance for the serious worker or experimenter, whether he be professional or amateur. It treats the subject of photography in a most dignified and scientific manner, giving detail and authentic information on about every important process.

For the scientist doing biological photography in educational institutions it will be found to fill an immediate and long-felt need. Each chapter covers its subject clearly and completely. The book not only contains a subject index but an appendix of a list of the more important reference works on photography and a separate reference to technical journals. Since photography has become a highly scientific subject the importance of reference can not be expressed too strongly.

The first edition was well received, being published in 1927. The second edition, which was published in 1931, has been revised. The author has capitalized on the criticisms and suggestions of his first edition. The text matter, where required, has been entirely rewritten and new methods have been described to bring the contents to date.

Mr. C. B. Neblette is a member of the faculty of Texas A. and M. College and has done considerable editorial and descriptive writing.

Motion Picture Photography. Carl Louis Gregory, F.R.P.S., with chapters by authorities in their respective fields. Second Edition, edited by Herbert C. McKay, A.R.P.S. 435 pages, approximately 160 illustrations, most of which are full page halftones. Price $6.00. New York: Falk Publishing Co., Inc.

The first edition of this book was published under the name "Condensed Course in Motion Picture Photography" and was copyrighted in 1920. The second edition was published in 1927 and has been improved and revised. This is indeed a fine book for the beginner as well as the advanced worker in biological cinematography.

One of the outstanding features is that it has a definite appeal to the photographer who makes only a very few feet of film per month but also tells him how thousands of feet are made and processed in the large studios. It not only gives specific instruction on the camera side of making motion pictures but treats the laboratory work in an interesting manner.

There is a chapter on animated cartoons or diagrams which are becoming of utmost importance in biological cinematography. Another chapter treats the technical side of the subject of submarine cinematography. Illustrations of biological subjects enhance the text as examples of this type of work.

It is interesting to know that this is one of the few books that gives a method of making direct positives on 35 mm. film. For reading and reference it is worthy of a place on any photographer's book shelf.

It contains a bibliography, appendix, glossary, and index.

ABSTRACTS

Time-lapse Cinematography in Research. Raymond Evans. Jour. of the Society of Mot. Pic. Eng. May, 1931. Vol. XVI, No. 5.

This article supplements a previous paper, *Apparatus for Time-lapse Motion Picture Photography*, by Howard Green, published in Trans. Soc. Mot. Pic. Eng., No. 26 (Nov., 1926, p. 147). The paper by Mr. Evans describes further some of the applications of the time-lapse camera in conducting research work in relation to agriculture.

Instantaneous Photomicrography of the Blood Platelets. Reed Rockwood, M.D. and Charles Sheard, Ph.D. Archives of Pathology and Laboratory Medicine, May, 1926. In this paper the authors discuss the photographic technique involved in photographing blood platelets as well as the morphology of the platelets. These photographs were made at a magnification of 1900, under dark field illumination and the exposures ranged from 1/5 to 1/2 second. The authors used a high intensity arc light. Their paper contains a diagrammatical sketch of the circuit required to produce a current of 25 or 30 amperes.

Teaching Health with Pictures. C. E. Turner. Journal of the Society of Motion Picture Engineers; Vol. XVI, May, 1931.

The value of motion pictures in teaching children is discussed, and shows the author's conception of the benefits derived from this medium of education.

Perfecting Your Film Records. Surgical Movie Technique. Louis M. Bailey. Medical Economics, April, 1932.

This article gives hints as to the number of physicians making medical films and something of their quality. It also embodies information as to how cinematographic technique can be improved to conform with surgery. Only 16 mm. film is considered.

TENTATIVE PARTIAL PROGRAM OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

The following, which is purely a tentative program, will give some idea of the speakers at the convention of the Biological Photographic Association. This is subject to change, revision and improvement.

1. Mr. Zieler of the E. L. Leitz, Inc. will discuss sources of light and alignment of the illumination for low, medium, and high magnification, and selection of light filters for photomicrography.
2. A representative from a publishing house will speak on the type of prints desirable for publication.
3. A representative of the Eastman Kodak Company will present a paper on emulsions.
4. Mr. Terlow, formerly of the Rockefeller Institute, will speak on ultra-violet light in photomicrography.
5. "Eyes of Science" (A motion picture and talk by the Bausch and Lomb Optical Company describing the making of a lens).
6. A short talk on the advantages of 16 mm. films in medicine to be followed by three or four 16 mm. motion pictures and a brief résumé as to how they were made.
7. Mr. Carlson will show his motion picture of defective children due to poor delivery. Miss MacMullen of the Babies Hospital, and Mr. Dunn of Cornell will also show some biological films. Possibly Professor Bayne-Jones will present some motion pictures of bacteria.
8. There is a possibility of the presentation of an all sound, all color medical motion picture by the Art Department of the University of Maryland, which is now in the process of being made.

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FOR SALE: Universal 35 mm. Motion picture camera. 400 foot capacity with Goetz F 3.5 lens. Perfect condition, a fine camera for medical and other biological photography. Original cost $500.00. Will sell for $125.00 cash. Box No. 2, this Journal.

THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION is planning a motion picture film library of both 16 mm. and 35 mm. films. With the exception of expense of shipment, etc., the use of this library will be free to members of the Association. The JOURNAL will appreciate any suggestions as a means of developing this library.

MAR 1 8 1933

Volume I DECEMBER, 1932 Number 2

The Journal of the Biological Photographic Association

Official Publication of the Biological Photographic Association
Published quarterly at 450 Ahnaip St., Menasha, Wisconsin

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The Journal of the Biological Photographic Association

will contain articles on

Photomicrography
Cinematography
Cinemicrography
Clinical and Gross Photography
Lantern Slide and Motion Picture Projection
Processing Room Technic
New Ideas and Equipment
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THE PURPOSE of this Journal is to keep the biological photographer posted in the latest developments in photographic technic, and the proper use of equipment and materials in relation to the biological sciences. It will contain articles by authorities in the fields of biological photography. They will tell, in simple language, how to obtain what are ordinarily considered difficult pictures in the easiest possible manner. They will discuss new equipment and its uses. The Journal will have pictures and articles on advanced photographic apparatus constructed by the research workers in the photographic departments of the foremost American and foreign Universities, including Medical and Dental Schools.

It will be the most complete source of technical information for the biological photographer. This Journal is sent free to members of the Biological Photographic Association. The dues to this Association are $3.00 per year. For non-members of the Association the subscription price is 2.00 per year or $.50 per copy.

If you are a producer of any type of biological photography, if you photograph anything that is alive or has been alive you can not afford to be without this association and publication to advance in your profession. It will be to your benefit to mail your subscription to the Editorial Office of the Journal, or much better pay the extra dollar and become a member of the Association and receive the Journal free.

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For the further study of photography in relation to the biological sciences and to improve its technic.

Journal of the

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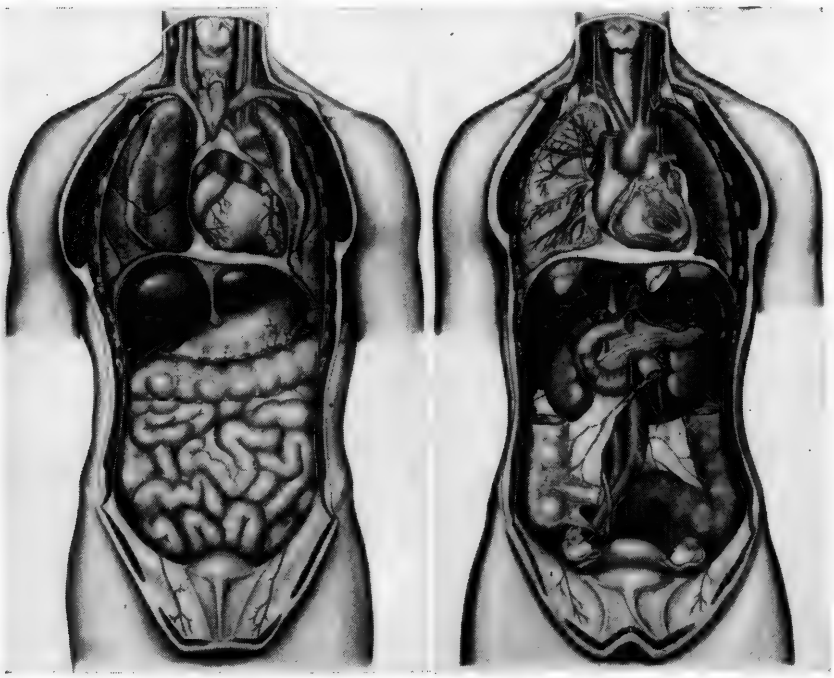

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Journal of the
Biological Photographic Association

VOLUME I DECEMBER, 1932 NUMBER 2

EDITORIAL

An Argument for the Elimination of Trade Secrets

IN THIS day of scientific reasoning men of intelligence do not tolerate the pettiness and lack of foresight of the individual in the sciences who depends on a few trade secrets for a livelihood. The possession of trade secrets stagnates his profession; he builds a false fort on a shifting and crumbling sand pile. His greediness for immediate gain warps his intelligence and eliminates his possible chances of success in the future. By possessing trade secrets he automatically admits that he is afraid that some one will get ahead of him; that another person will be able to do more with the situation. This fear tears down his ability to progress and makes him not only small in his own eyes but in the eyes of his fellowmen.

How much better, by far, it is to publish the information that you have spent days, months, even years to learn so that some other individual may not only have the benefit of your knowledge but may carry on from the point where you have left off; so that he may improve on what you have possibly originated or discovered.

Dr. Crawford William Long of Georgia produced proof that showed that he had used ether as an anesthetic in March, 1842, but he did not publish his discovery. Therefore when Dr. William Thomas Green Morton of Massachusetts later demonstrated to a group of physicians the sleep-giving qualities of ether he was immediately given credit for discovering anesthesia. It was necessary for Long to go to much trouble to prove his former use of the drug. For many years afterwards it remained a subject of debate as to who was the true discoverer of the anesthetic properties of ether.

So the moral gained from this example is: Publish the thing

that you think is new, better or different. Credit will be given to you for what you have done.

Aim towards standardization so that once a technique is established in its simplest form, other incomplete fields may be conquered. This is the rock foundation upon which any true science builds its temples of learning.

Make your profession a most honorable and dignified one. Command respect for profound knowledge of your subject, not for a few petty professional secrets and disseminated information.

CARL D. CLARKE

THE OCTOBER CONVENTION OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

THE SECOND annual convention of the Biological Photographic Association was held on October 21 and 22 in Sterling Hall of Medicine at Yale University. The meeting was opened with an address of welcome by Dr. Milton C. Winternitz, Dean of the School of Medicine, Yale University. Dr. Winternitz was followed by Mr. Ralph P. Creer who, as president, delivered his message to the Association.

The first scientific paper was that of Mr. W. Zieler of E. Leitz Co., who spoke on "Sources of Light and Alignment of the Lens System and Selection of Light Filters for Photomicrography." This paper was followed by another on "Motility in Bacteria" by Mr. R. P. Loveland. Accompanying the paper as illustration was a 35 mm. motion picture which was not only extremely interesting but most enlightening from an educational standpoint. After the picture the gathering adjourned for lunch.

On returning to the hall some time was taken up with a business meeting, after which Dr. A. Plato Schwartz spoke on "Photography in Medicine, Surgery and the Biologic Sciences." This talk was illustrated by three 16 mm. films of various medical subjects made by members of the Biological Photographic Association.

A room adjoining Sterling Hall was occupied by an exhibit of photographic and optical equipment that was extremely interesting and instructive. The lobby of Sterling Hall was used for exhibiting work done by members of the Association. After looking at this exhibit one could not help but be amazed at the various forms of photographic work that biological photographers are

called upon to perform. Natural color photographs were plentiful in this exhibit.

At 7:00 P.M. the banquet was held in the auditorium of the Y.W.C.A. where the members not only had a most enjoyable time but attended to the business of the election of officers.

The program on Saturday was as follows:

9:00 A.M. Ultra-Violet Light in Photomicrography—Mr. Adrian Ter Louw
9:45 A.M. Prints Suitable for Publication; their Preparation, Grouping, and Mounting—Mr. Louis Schmidt, Rockefeller Institute
10:30 A.M. Eyes of Science (35 mm. motion picture illustrating the manufacture of lenses, presented and discussed by the Bausch & Lomb Optical Company)
11:15 A.M. Photographic Emulsions—Mr. E. K. Wills, Eastman Kodak Company
12:00 M. General Discussion: Copying of X-rays for lantern slides and prints—Led by Mr. Schmidt
1:00 P.M. Adjourned.

Articles read at this convention will be published in later issues of this JOURNAL.

SOME PROBLEMS IN BIOLOGICAL PHOTOGRAPHY*

MAX POSER, PH.D.
ROCHESTER, NEW YORK
Optical Expert, Bausch & Lomb Optical Co.

CLINICAL photography comprises quite a range of different photographic methods, such as macrophotography, photomicrography, cinematography, cinephotomicrography, etc., but rarely microphotography, such as photographing the text of the Lord's Prayer on a grain of rice; or the recording of fluorescence with certain materials, ultra-microscopic particles, etc.

The question often arises: What should our equipment consist of? We will consider first ordinary photography.

The rendering of a full length figure of a person or any part of his body in a pleasing perspective on the recording photograph depends largely on the distance between the camera lens and the person to be photographed, irrespective of the focal length of the lens or the size of plate used.

Common practice has proved that the room or studio of a clini-

* Received for publication June 20, 1932.

cal photographic department should be about 20 feet in length in order to meet the various conditions involved.

The next item to be considered is the photographic objective. For clinical macrophotography the type of photographic objective known as anastigmat will be found most suitable for full length or part of figure. This is due to the better aplanatic field (flatness of field) that these lenses offer without stopping down the diaphragm as compared with the portrait lens. For instance, a 10″ portrait lens with an aperture of F:8 will not quite cover a 5″ x 7″ plate critically, while an anastigmat of the same focal length will cover a 5″ x 7″ plate critically with an aperture of F:6.3. From this it will be seen that the anastigmat is much faster than the portrait lens for a given covering power and consequently is to be preferred.

The clinical photographer is called upon to perform a large variety of service in macrophotography, and in order to be most efficient, the selection of the type of photographic objective which is most flexible in application is most important. A suitable lens of the type mentioned you will find in the well known convertible Protar Series VIIa. This type of objective offers very desirable lens combinations, and thus a variety of different foci is available for the clinical and professional photographer, which must be considered preferable for all-round work.

When photographing a patient for one reason or another, the most natural countenance of the person and his physical conditions at the time the photograph is taken should be depicted in order to serve as a true and reliable record.

To obtain photographs with the desired characteristics, the illumination of the subject should be carefully studied.

An important optical factor is often overlooked; namely, too much stopping down of the objective affects the illumination of the subject to such an extent that the desired relief of the photograph is greatly impaired.

The operator should study the image on the ground glass screen with the lens at full aperture and observe the effect upon the image when stopping down the objective.

Long focus objectives will yield a more acceptable perspective for a given size of picture and should, therefore, be given the preference.

Curved surfaces such as the contours of a face, etc., should be illuminated with a soft diffused light in order to prevent hard-

ness with the tendency to exaggerate bones and muscles, furrows, etc., in the photographs.

Macrophotography of specimens, with fine detailed structure but otherwise fairly flat, or even in form requires the use of specially corrected lenses such as the Tessar Series Ic working with F:4.5 or IIb working with F:6.3. In order to render visible the finest details of such objects, when taken in natural size or larger, it is advisable not to stop down the aperture of the objective below F:11. In order to obtain a good rectilinear effect of the object to be photographed, it is advisable to select a Tessar lens with a focal length approximately equal to the diagonal of the specimen to be photographed.

Also here the illumination of the object is to be carefully considered in order to avoid disturbing reflexes.

The light source to be chosen for this kind of work should furnish a uniformly diffused light of not too great intensity, and in order to bring out better contrasts with specimens of pale color, a suitable filter will be found very advantageous. Orthochromatic, or better still, panchromatic plates should be used in order to obtain the desired color rendering in the finished photograph.

Suitable filters of various shades in green will be found very useful in photographing specimens where the red color is predominating, while various shades of blue filters will be found useful in subduing excessive contrasts usually experienced when photographing white or light gray colored specimens with darkly colored areas intervening.

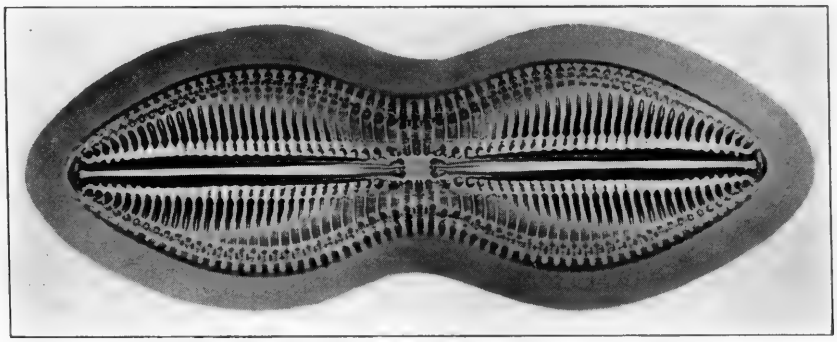
Photographs taken through a blue filter should always be developed with a weak developer and the development prolonged, thus obtaining details in the dark areas of the object without over-developing the high lights.

Yellow or orange colored filters are very suitable in many cases when orthochromatic plates sensitive to yellow and gray are used.

The photographic camera to be recommended for ordinary studio work and photographing of large specimens should be provided with an extra long camera extension. The regular studio camera of large size mounted on a firm stand equipped with elevating gear and tilting device will be found very suitable. For studio work the maximum extension of the camera should represent somewhat more than twice the focal length of the largest

focus objective used. For copying work the studio camera also will be found very useful, but in cases where specimens are to be photographed in jars, etc., it will be found advantageous to have a special camera of the ordinary type but with long camera extension provided for, arranged so that it may be used either vertically or horizontally or in any other angle required.

Macrophotography in natural colors should be fostered, moreover, since with the present modified methods the entire process is greatly simplified and less costly.



Navicula Crabro: Ehrb.
Magnification 500:1.

PHOTOMICROGRAPHY

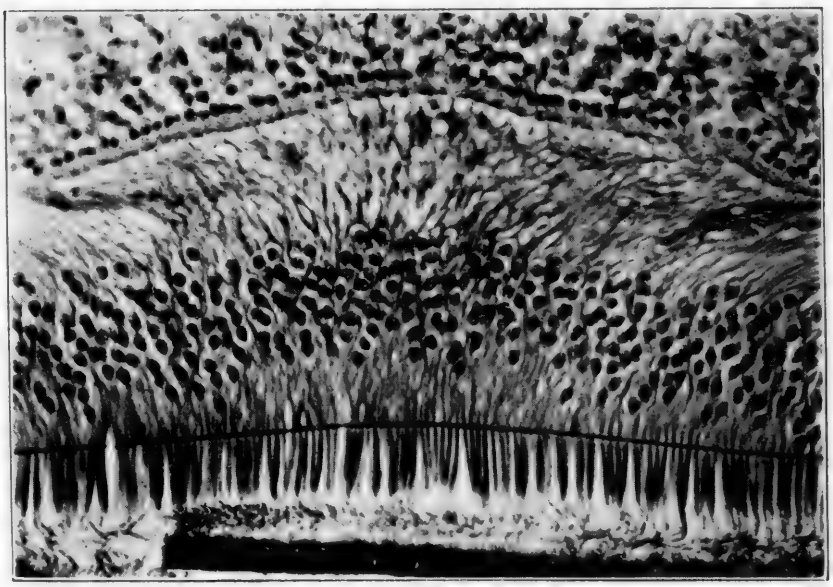
The study of objects with the aid of the microscope is greatly facilitated if we familiarize ourselves with certain rules established in order to comply with so-called optical laws pertaining to scientific microscopy.

We will consider low power work to start with. Suppose our object on the microscope stage to be studied is of such dimension that a 32 mm. focus objective is required in order to cover the entire object field desired. In all such cases the rule should be to illuminate the specimen with the aid of a low power condenser lens of about the same focal length as that of the objective in use. The source of light should be homogeneous, that is to say, equal in intensity, as for instance the ribbon filament lamp or, better, the Pointolite Lamp. Electric arc lamps are not of importance in low power work, except when projecting the image of a micro specimen on a screen, to serve the purpose of demonstrating such

objects when lecturing, or when making an enlargement of such objects to a considerable size direct on bromide paper.

Micro objects as a rule are stained specimens, and to use a suitable colored filter will be found in many cases of great aid in order to bring out fine details of the object with balanced contrasts.

The use of orthochromatic panchromatic plates with fine grain is very important when taking photomicrographs of stained objects, and a careful study should be made in order to select the



Human Retina: Whorl.
Magnification 300:1.

right kind of filter to suit the staining solution used in the preparation of the micro object. A small hand spectroscope will be found very useful in such studies of staining solutions. It will enable the operator to record absorption bands of the staining solution and to select a color filter which will pass freely the light of that portion of the spectrum absorbed by the color solution thus examined. Such filters when used with the specimens stained with the above mentioned solution will then absorb the color of the staining solution so that the object will appear on the sensitive plate of the camera as if it were stained black, and thus in-

sure maximum contrast. This method is particularly to be recommended with faintly stained specimens lacking in contrast.

For low power photomicrographic work where large covering power is essential, the following objectives are most suitable:

The Micro Tessar Series with a range of foci of 16 mm., 32 mm., 48 mm., and 72 mm.

Micro Planar Series, 20 mm., 35 mm., 50 mm., 75 mm., and 100 mm.

Micro Microtar Series, 35 mm., 70 mm.

These lenses are designed to be used without eyepieces, and in order to avoid internal reflection, the microscope body tube should be of the large diameter design, especially adapted for photomicrographic work.

In order to get the best results with this type of lens, it is essential to fit in the micro substage simple condensing lenses of a focus approximately equal in length to that of the objective used. Care should be taken that the illuminating system is so arranged that the light entering the substage condenser should be as nearly parallel as possible.

For medium power work micro objectives of a focal length ranging from 16 mm. to about 4 mm. come into the consideration, and for high power as well as oil immersion work the range of foci will be approximately from 3 mm. to 1.5 mm. The size of the object field to be covered and the resolution desired determine the power of the objective to be used.

No general rule can be given, except that the numerical aperture of the objective to be used must be commensurate with the size of the structural details of the object to be rendered visible. Magnification is a secondary consideration, since the resolving power of a microscope objective depends upon the numerical aperture of the objective employed and the wave length of light used for illumination of the object.

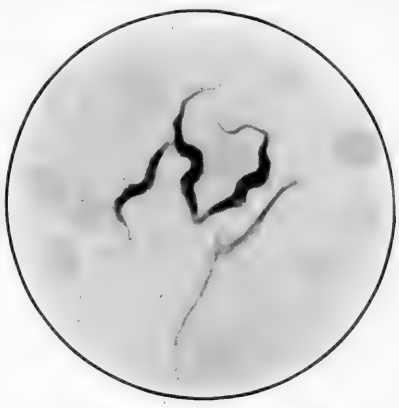
A considerable variety of micro objectives is now available, and full details as to their characteristics and merits are given by the various manufacturers in their respective catalogues. To give details here as to these various micro objectives will not be possible without going into a very lengthy description, but any of the various makers will furnish full information of their products as may be desired by the party interested.

The question often arises: What is the best objective to use for

the one or the other object to be examined or photographed? Of course, much depends upon the object itself and what is to be expected from the photomicrographs to be taken.

In nearly all cases where low or medium powers are considered without laying great stress on the maximum resolving power for a given numerical aperture, *achromatic* objectives used with ordinary eyepieces, as recommended by the various makers, will suffice.

Trypanosoma Lewisi.
Magnification, 2250:1.



Trypanosoma Lewisi.
Magnification, 750:1.

With achromatic oil immersion lenses, however, it will be found advantageous to use compensating eyepieces in order to obtain a better color correction.

Achromatic objectives are not free from secondary spectrum; that is to say, the contours of an object when viewed through an achromatic objective present more or less small color fringes, which in turn impair to a certain degree the definition of the finer structure of the object. In photomicrographic work such color fringes are particularly noticeable, and in order to overcome these obstacles, *apochromatic* objectives should be used. Apochromatic objectives are of a superior correction for color and aplanatic field and are free from secondary spectrum, provided they are always used with compensating eyepieces. As a matter of fact, the compensating eyepiece forms a part of the apochromatic correction of the objective. This is in order to eliminate the secondary spectrum, thus rendering the structural details of an object free from color defects and enhancing the definition of the micro object to a remarkable degree.

The question often arises: What micro objective furnishes the greatest depth of definition or penetrating power?

Depth of definition cannot be made a correcting factor of the objective; it depends chiefly upon the numerical aperture of the lens and magnification.

As a rule, the greater the numerical aperture of the lens, the less the depth of definition, but the greater the resolving power of the microscopic objective.

From this it follows that when we reduce the numerical aperture of the objective of a given power by either a diaphragm within or close above the objective or by stopping down the illuminating cone, we increase the depth of definition or penetrating power of the objective, but at the same time decrease the resolving power.

The operator should, therefore, carefully observe how much stopping down of the objective is permissible without losing the detailed structure of the object to be resolved.

With stained specimens such as bacteria, the full numerical aperture of an oil or water immersion objective should be realized in order to obtain best results and to avoid disturbing diffraction effects.

Sections of tissues with considerable thickness often require stopping down of the objective in order to get the deeper layers well in focus.

No direct rule can be given to suit the numerous different specimens to be examined or photographed with the aid of the microscope as occur in the routine work of a biological photographer's laboratory. However, it is advisable to use microscopic objectives of a power not in excess of what is really required in order to meet a given case.

Flatness of field is also a factor to be considered, particularly in photomicrography.

Here, also, it is advisable to select the microscope objective with a numerical aperture not in excess of what is required in order to meet the conditions of a given case. If it should be necessary to use higher power eyepieces than those usually employed in order to obtain the desired magnification, this is quite permissible.

As a rule good results are obtained with a magnification not exceeding 1000 times the numerical aperture of the objective in use.

Within recent years wide field eyepieces have been designed by

various microscope manufacturers. These are known by the name of Hyperplane, Homal, Periplane, Planoscopic, etc. These types of eyepieces, however, are not of a correction to take the place of the compensating eyepieces to be used with apochromatic objectives, but have color compensation about midway between huygenian and compensating eyepieces and are useful with the higher powers of achromatic and fluorite objectives.

An important factor in microscopy, photomicrography and micro projection is the correct centering of the entire optical system with the light source. Every optical component must be carefully centered in order to insure good results, and particularly in photomicrography it will be found advantageous to use specially designed objective holders fitted to the lower end of the microscope body tube. These objective holders or changers as made by various optical manufacturers are equipped with centering appliances so that each individual microscope objective may be accurately centered with the entire optical system.

The photomicrographic apparatus in general should be of a rigid construction in order to eliminate vibration, and if a solid foundation is not available in the laboratory, shock absorbers should be provided for. The camera should extend sufficiently to meet the requirements for all-round work, and a remote fine focusing arrangement enabling the operator to focus the object from the position of the ground glass screen at the end of the camera is essential. For fine focusing the use of a plate glass screen with diamond markings in the plane of register will be found preferable to the ground glass screen; a specially designed focusing magnifier is required when using the plate glass focusing screen.

In all microscope work the correct illumination of the object is of great importance.

For many years it has been found that when focusing the image of the source of light by means of the condensing lens system so that the image of the source of light is projected in the object plane, excellent results are obtained provided that the source of light is homogeneous and that the image of the source of light thus projected fills the entire aperture of the microscopic objective in use.

Another method to be recommended is to project the image of the source of light in the plane of the iris diaphragm of substage condenser. When using this mode of illumination, several con-

densing lenses of the required focal length must be used in order to achieve the desired results with low, medium, and high power objectives.

Microphotography in natural colors should not present any difficulty, but the color screen used must be adapted to the characteristics of the artificial source of light which in most cases is insufficient in blue and violet rays as compared with daylight.

In cine-photomicrography the methods used for photomicrography may be employed, with the exception, of course, that since we deal here with moving objects, a special shutter device is required.

To take a photomicrograph of living cells in normal or diseased conditions must be considered in itself of great importance and should be given close attention by the photomicrographer.

Numerous objects present themselves suitable for cine-photomicrography, but space will not permit us to go into the details.

The equipment to be recommended for cine-photomicrography depends upon the work involved. Any changes of a living object on the microscope stage which one wants to record on a film can be photographed by simply connecting the cinematography camera equipped with the special shutter device, electric motor and gear arrangement, to the microscope tube. The eyepiece tube is to be provided with an amplifying lens of either 3X, 5X, or 7.5X, according to magnification required. The optical system of the microscope may be focused with either the coarse or fine focusing arrangement of the microscope, on the photographic film while viewing the object through the observation eyepiece.

The shutter on the cinematographic camera being provided with an electric motor and gear arrangement permits a ratio of exposures according to gear position.

With the Bausch & Lomb cine-photomicrographic outfit the speeds are given herewith:

Gear Position	*Picture Speed*
1	16 per second
2	8 per second
3	2 per second
4	1 every 2 seconds
5	1 every 8 seconds
6	1 every 32 seconds
7	1 every 2 minutes 8 seconds
8	1 every 4 minutes 16 seconds

In other apparatus of this kind more or less similar speeds are provided for.

In order to control the focus and position of micro objects as they appear in the image on the film, a specially designed observation eyepiece is required, which permits viewing the object during the period the pictures are taken.

Many interesting living micro objects may be studied with this apparatus. To observe the growth of living tissue presents a very interesting study: haemolysis, agglutination, phagocytosis, mitosis, growth of bacteria, destruction of tissues, etc., by parasites and many other important observations can be made with comparative ease; thus the apparatus also proves invaluable for teaching purposes.

The 16 mm. film to be used with this instrument will be found useful in small classroom work, proving very economical and easy to handle. For large classroom work and special research work the 35 mm. film will be found preferable.

Ordinary cinematography for taking pictures in the operating room requires special illumination facilities to be adapted for the kind of work involved. It is advisable that the operator study each individual case before the photographs are taken, in order to avoid as many failures as possible.

Disturbing shadow effects and glare, reflexes, etc., must be avoided, moreover, since any of these defects are greatly magnified when the finished film is projected upon the screen. An operating lamp designed to eliminate disturbing shadow effects, etc., will be found useful to facilitate the work.

The next issue of the JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION will contain two articles on the making of animated motion pictures. One of these articles will discuss fully the various types of apparatus used for this work and how they may be constructed for any laboratory. The other article will describe the making of biological drawings and their animation.

THE PHOTOGRAPHY OF SMALL OBJECTS*

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FEW PHOTOGRAPHERS realize that small objects can be photographed with comparative ease. This is a phase of photography that is generally dreaded and avoided when possible by the average photographer. However, it can be made quite simple and fascinating when approached in the right manner.

There are many uses for such photography. To the entomologist it is indispensable. The majority of insects are too large for the lowest power on the microscope and too small for a regular clinical camera. Many schools desire chart size photographs of minute insects for classroom study. An ideal way is to photograph them with a Micro Tessar lens and enlarge the negative in an enlarging machine to the desired size. The clarity and detail contained in the finished product are most gratifying. While on the subject of insects it might be worth mentioning that some specimens, such as mosquito larvæ, are photographed better in water as the hairy spines and antennæ will stand out in a natural position. Small animals, such as salamanders are hard to photograph due to their mobility, but this can be overcome by placing them in a 1:1000 solution of chloretone which will act as an anesthetic without ill effects.†

Now, let us consider the camera suitable for photographing small objects, other than those seen through a microscope. As most makes are acceptable, very little need be said. The main requisites are that the camera should be sturdy and rigid, as the slightest vibrations will often ruin an otherwise perfect photograph. The camera most suitable is one of the view camera type having at least a 20″ bellows extension, ground glass, and lens mount or lens board to facilitate the changing of lenses. Cameras manufactured by the various optical houses for photomicrography are very suitable for this work, especially those of the vertical type. They can be equipped with a light tight sleeve for connection

* Received for publication June 1, 1932.

† This method originated by Dr. Ross G. Harrison, Zoological Laboratory, Yale University.

to a microscope, if necessary, and a rack and pinion focusing mount for the Micro Tessar lenses. These Micro Tessar lenses are of short focal length and are especially corrected for this work. The 72 mm. lens will fit into the rack and pinion mount without

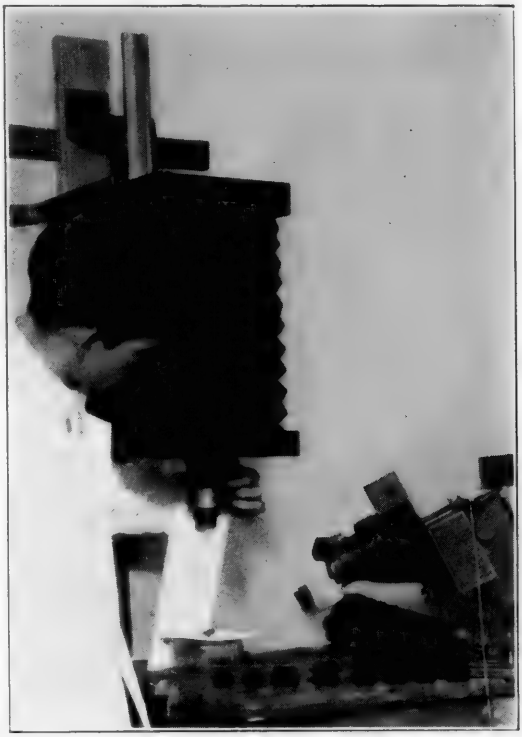

FIG. 1. Typical set-up for photographing small objects.

In this illustration a lens of 7 inch focus is on the camera. The Micro Tessar lenses operate much closer to the subject. The lenses on the table vary from 32 mm. to 5 inches in focus. The lens to the extreme right is used for critically focusing the subject on the ground glass.

an adapter, whereas, the 48 and 32 mm. lenses need an adapter. The 72 mm. focus means that the lens comes into focus at approximately 72 mm. from the object. With the bellows extended two feet this will give a magnification of approximately 8 times. The 48 mm. lens when placed 48 mm. from the subject and the

bellows extended approximately two feet, will give a magnification of about 12 times. The 32 mm. lens with bellows extended two feet gives a magnification of approximately 20 times. By making the bellows shorter and slightly changing the focus, lower magnification up to these points can be obtained. For example, when using the 72 mm. lens, pictures can be obtained of a small object from its actual size to the maximum magnification. In this case the magnification is 8 times. The 32 and 48 mm. lenses can also be used in place of the regular microscopic objectives. These lenses have diaphragms and function from F:4.5 to F:22.

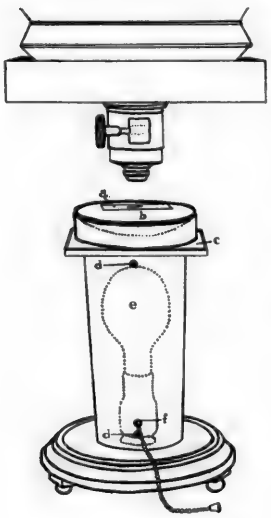

FIG. 2. Improvised light box for transparent subjects.

a. Microscopic slide.
b. 4½" condensing lens.
c. Two layers of ground glass.
d. Holes for escape of hot air.
e. 100-watt bulb.
f. Chain for turning off current.

The light source can be of practically any variation from the incandescent tungsten bulb and reflector, to the carbon arc with condensing lens in front for pointing. For such work the modern ribbon filament bulb will also be found satisfactory. White cardboard reflectors are often indispensable in the photomicrography of opaque objects, to give modeling and to illuminate dark shadows. Ofttimes, to dispense with highlights, it will be found necessary to submerge the object in water, preferably distilled water. At times, ground glass or tracing cloth placed between the light source and the object to be photographed, will be found helpful.

Of course, the background is selected according to the subject so as to produce a maximum of contrast. A gray background is not as practical as the black or white because, when using high magnification dust marks become nasty blotches which are difficult to remove by retouching. When photographing small light objects such as embryos, that have been fixed in formalin, a black background is practical. Even though the specimen is to be photographed under water a pure black background can easily be obtained by coating the inside of the container or petri dish with a dead black paint, or a combination of petroleum jelly,

wax, and lampblack. The wax will give enough body to render floating specimens immobile, by pinning. When an extreme low power photomicrograph is desired and the regular 16 mm. lens on your microscope is not sufficiently low, a good picture can be obtained on this camera with one of the Micro Tessar lenses by placing the microscopic slide over an improvised light box and interposing the proper filters. Another method, which is sometimes satisfactory, is to place the microscopic slide in an enlarging machine and enlarge the slide to a panchromatic or panchromatic process film, using the regular filters. Sometimes pleasing results can be obtained by enlarging to a process plate, especially if the slide has been stained with eosin. The eosin will photograph very dark thus giving a contrastive picture. Even though the color rendering is not true the result may be what is desired. This method of enlarging should be used only when a lack of equipment necessitates it.

FIG. 3. Banana Fly. Photographed with 32 mm. lens as illustrated in Fig. 2. Both overhead and underneath lightings used. Magnification 15x.

There have been many methods published of determining the correct exposures in this and other fields of photography, but after all, there are so many factors involved that the most accurate way is to make exposures of different lengths of time, and select the best exposure. This can be done with one piece of film by exposing the whole piece a calculated length of time such as one-half second, then partially pushing in the slide of the plate holder and exposing another one-half second and so on, in geometrical order, until the entire piece of film has been exposed. It will be found that as the magnification doubles the exposure also approximately doubles. This test should

FIG. 4. Longitudinal section of fractured tooth (eosin strain). Enlarged in enlarger upon process plate. Magnification 2½x.

be made with each lens and recorded for future use. Although there are factors involved which will necessitate the continual changing of exposure, much time and labor can be saved by standardizing your exposures in this manner.

In conclusion, let the purpose of this paper be emphasized. It is not to present anything unusual, but is merely a résumé of some of the smaller things that count so much toward making good photographs. There are tricks in all trades. It is often one minor factor that draws the line between a good and bad photograph. It can be from constant attention to minor details and a knowledge of the "best way" that produces the perfected picture.

A METHOD OF PHOTOGRAPHING GROSS SPECIMENS*

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As is well known, the classical method of photographing a fresh or a preserved specimen is based on immersion of the material in a deep dish or tray filled with water or paraffin oil. This procedure eliminates the sparkling highlights caused by the wet surface.

We were compelled to discard this method and to seek a suitable substitute for the following reasons:

First, in photographing the body of an animal at autopsy, such as a mouse, rat, guinea pig, or rabbit, which is usually fastened to an operating board, it was found that very large vessels were required. Furthermore, the fur was represented unsatisfactorily.

Second, specimens containing air or gases, such as lungs, intestines, etc., floated in the liquid and therefore could not be immobilized.

Third, the above method had a tendency to flatten the lighting and to destroy plasticity. This was due to the effect of reflected light from the liquid and walls of the vessels containing the preparation.

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* Received for publication July 2, 1932.

The method which we have substituted, and which may possibly have been used elsewhere, is an adaption of the technique employed by commercial photographers, whereby automobiles or furniture are photographed in the open, under a tent, when it is desired to obtain a picture free from objectionable highlights.

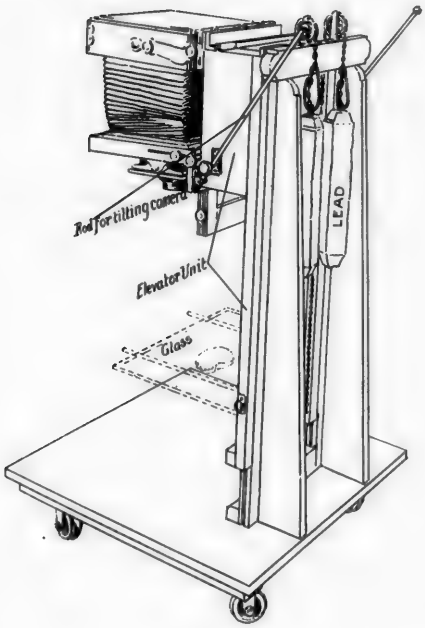

FIG. 1

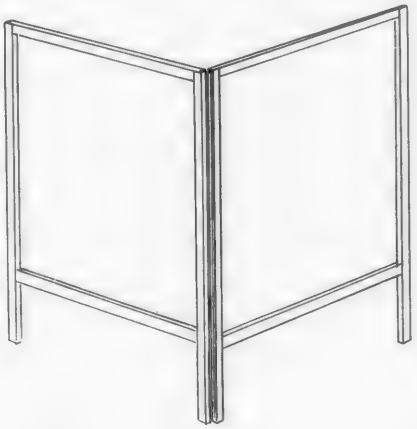

FIG. 2

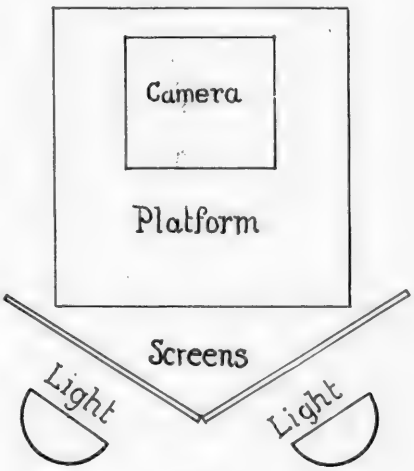

FIG. 3

The latter objections also confront us so far as the pathologist is concerned, for he may be confused by the sparkling highlights on a wet specimen and interpret them as lesions. In the method used at the Rockefeller Institute, the material is placed on a small

platform or shelf under a vertical camera. Two 1000-watt bulbs in reflectors are used for lighting the specimen. These are placed behind a two part screen, covered with white Holland curtain material. A sheet of white cardboard fastened on the camera stand

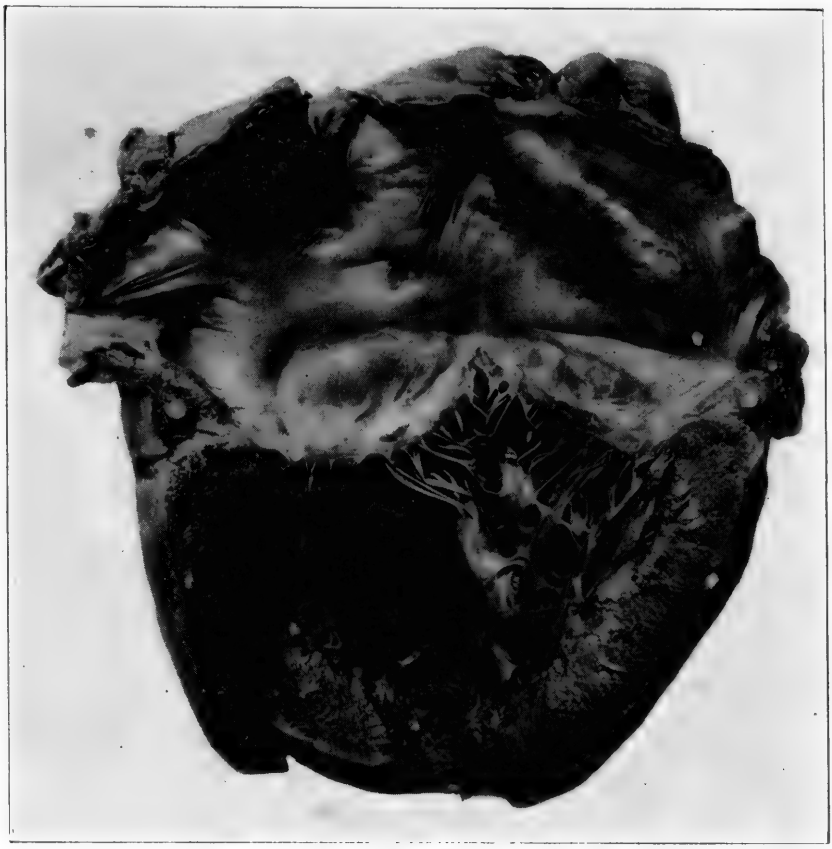

FIG. 4

reflects light into the shadows. By moving the hinged screen and lights, then increasing or shortening the distance between lights and specimen, the desired lighting effect is obtained. Thus pictures that are well rounded, with clear detail in the shadows, yet free from sharp points of light, are produced.

The apparatus used by us was designed in the Illustration Division of the Rockefeller Institute for Medical Research and built in its shops. This department employs an Eastman commercial camera but a view camera may be used as well. The stand consists of a platform, mounted on large casters having three-inch

rubber-tired wheels. From this base rise upright supports, on which is a grooved frame permitting the camera bed to slide up and down (the elevator unit) to a range of about 2½ feet. On top of this frame is hinged a square base to which the bed of the camera is clamped or screwed. Hinges and a pair of supporting rods make it possible to place the camera at different angles so that it has a range varying from directly downward to some degrees above the horizontal. The elevating unit plus the camera are counterbalanced by lead weights and are very easily raised and lowered. There are thumb screws to anchor the elevator and tilting devices. About one foot above the base the uprights are pierced to receive two one-half inch glass rods on which may be placed a ground or clear glass, to hold the specimen. Different shades of gray and black cardboard placed on the base platform may be tried until the most suitable one is found. If a white cardboard is used there is generally no need for opaquing the background on the negative. In all cases, if the lights are properly placed there need be no shadows of the specimen on the background.

The camera bed is marked for bellows length to produce full, three-fourths, and one-half sizes. When set, all that is necessary is to raise and lower the camera on the sliding elevator unit until the image is in focus, then to stop down the lens and expose. The camera is equipped with 8″ x 10″, 5″ x 7″, and 3¼″ x 4″ backs, the latter being employed mostly for color photography. A Goerze Celor lens, 8½″ focus, is used.

The apparatus is portable and can be used horizontally for bedside work.

A LIGHTING SYSTEM FOR PHOTOGRAPHY OF PATHOLOGICAL SPECIMENS*

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From Laboratories of Mt. Sinai Hospital

THE AVERAGE biological photographer is conscious of the fact that an accurate knowledge of light and the use of filters is essential. Dr. Luis Gross, Director of Laboratories, Mt. Sinai Hospital, observed that certain minute and colorless pathological

* Received for publication June 13, 1932.

lesions were not visible on prints of negatives taken by most lighting methods.

With the object in mind of overcoming this difficulty, we began to experiment with lighting arrangements. At first was constructed a small box with an opening at the front and back, on the floor of which were four electric bulbs. A piece of ground glass was placed on the top of the box to hold the specimen and also to diffuse the light from below, thereby creating a black background on the negative or a white background on the print. This experiment furthered our hope to improve on the existing methods of making photographs of pathological specimens.

The next problem to be developed was to obtain even concentration of light from above to the specimen on the ground glass. Again we were conscious of the fact that the average lighting system does not give the desired results for our particular case. We then attempted to light the specimen through a tracing cloth diffusing screen similar to the method developed by Mr. Louis Schmidt of the Rockefeller Institute for Medical Research. This screen did not solve our problem because the deeper lesions and cavities were not accentuated sufficiently.

FIG. 1. The front and side views, showing five switches, the opening below the ground glass and the electric light connection.

After careful analysis of our collection of finished negatives and prints we have endeavored to aid in overcoming these various difficulties by the construction of a lighting arrangement in the form of a box to concentrate grouped lights on the specimen. The method employed in using this light box is very simple. First wash the specimen under low pressure running water for five minutes, and then sponge it with a pad made of cotton and gauze to remove moisture. Otherwise this moisture will very likely appear on the negative as highlights. Place the specimen on the ground glass which is located between the lights below and above. The box is provided with seven switches. To focus the specimen, turn on only the eight side lights.

The six front lights are not used unless a shadow does not clearly show with the use of the side lights. The four lights below the ground glass are not used before the specimen is ready for exposure. All lights can be manipulated by the various switches to obtain the desired results. Focus the specimen and adjust the lights, after which the desired filter is inserted in front of the camera lens. Following this, it is necessary to refocus and readjust lights. The next step is to close the diaphragm to the desired stop. The specimen is now ready for exposure, which is left entirely to the photographer's judgment. If a white background is desired on the positive, it is necessary to turn on the lights below the specimen during the time of exposure. On the other hand, if a black background is preferred, cut out the lights below and place a black paper or cloth under the specimen on the ground glass.

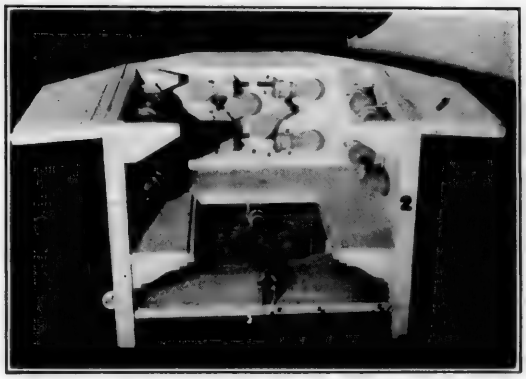

FIG. 2. The back view showing the eighteen 40-watt bulbs, inside view and the top-frame opened.

1. The top-frame can be opened and closed. Measurement: outside 26″ x 21″ x 11″; inside 12″ x 14″ x 11″.

2. From the top-frame to the second floor or the place of the ground-glass, 13 inches.

3. Above the ground-glass or the second floor—eight 40-watt bulbs—four on each side controlled by switches.

4. Above the second floor—front six 40-watt bulbs controlled by two switches.

5. Four 40-watt bulbs on the first or bottom floor with one switch.

In connection with the above experiment, we made filters from lantern slide plates cleared in hypo and stained with green, yellow and orange. These filters are used to show detail and brilliance in the negative. Our experience proves that the yellow filter is very good for photographing specimens which are highly colored. On the other hand, for specimens which are colorless, the orange filter proves superior to the yellow for such sections of the heart as the mitral, pulmonary and tricuspid valves. The green filter proved of little value.

Another difficulty other than those previously mentioned was

the selection of plates most suitable for this work. After experimenting with various makes, we came to the conclusion that the Gevaert Saho Plate was the best. We also prefer this plate for photomicrography.

THE FULL-TONE COLLOTYPE PRINTED REPRODUCTION*

ARTHUR C. SIAS

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EDITOR'S NOTE: This article by Mr. Arthur C. Sias is the first of a series on processes of printed reproduction to appear in this journal. Other articles on photo-engraving, lithography and other processes will be published in succeeding issues. Their object is to give the biological photographer a working knowledge of the various processes of reproduction so that he may put this knowledge to good account in choosing or advising the process to be used in the publication of his photographs.

WHEN a scientist enters his specific field of research and emerges with findings which are of interest to contemporary workers he has a generous desire to publish his data. A monograph is prepared and in many instances photographs are required to illustrate a condition or verify or add weight to a statement or conclusion.

The scientist knows that his words will be printed and readable. He often finds that the printed reproduction of his photograph either fails to illustrate the point for which it was used, or has been so retouched as to lose weight as evidence. It is no longer a photographic record but the retoucher's interpretation of the original photograph. There is a loss of shadow and of highlight detail. The reproduction does not contain the same scale of tone gradation as the original. Lines have been lost or darkened or lightened, their courses and contours changed due to the limitations of retouching. Dark grey areas have been swallowed by the blacks, light areas lost completely or contours changed by retouching, which was probably necessary to increase the tone range of the printing process used.

The value of the monograph is greatly reduced. The scientist is disappointed and much disheartened. The printer cannot understand. He made "excellent prints." Based on his experience,

*Received for publication September 26, 1932.

he probably did, but he can do no better than the limitations of his printing process.

The following procedure is respectfully suggested for the scientist who desires the best results in his publications:

First, to select a printing process which is capable of printing as nearly a facsimile reproduction as is possible photomechanically. The term "photomechanical" is used to distinguish between prints that are printed with ink and those that are obtained photographically.

Second, to choose a printer who has an understanding of the nature of scientific work, who appreciates that any retouching reduces the value of the illustration, and who has a realization that the best print for the purpose is not always a vigorous, pleasing picture.

Third, to consider the original from which the printer makes the copies.

If the scientist has some knowledge of the difficulties encountered by the printer in producing facsimile prints he can help immeasurably to obtain the final satisfactory reproduction by careful preparation of the original print supplied to the printer.

In all printing processes the greatest difficulty is to reproduce delicate shadow and highlight detail. For instance, let us assume that in the original the deepest tone is black. Within this tone there may be detail, either line or area, which is slightly lighter but barely discernible. This will be lost in the reproduction (retouching not considered) for, after all, the printing is mechanical and is not the chemical conversion of ultra microscopic silver particles. Similarly in the highlight detail faint lines on a white ground disappear; areas whose tint is just perceptibly darker than the white background are lost.

A pertinent question would be that if these tones or lines are not reproduced, why the term facsimile? The term has no doubt been misused. It shall be considered here as being the nearest approach possible at this time by photomechanical means. Exact facsimile reproduction is a purely scientific problem and for those interested reference is made to a paper published by L. A. Jones, on the "Theory of Tone Reproduction, With a Graphic Method for the Solution of Problems."[1]

This article concerns printing under commercial conditions by

[1] *Journal of the Franklin Institute*, July 1920, page 39.

operators trained to approach perfect tone reproduction. It also concerns preparation of the original to within limits reproducable by the process, to produce a print which illustrates satisfactorily the purpose for which it was printed, losing no weight as evidence through retouching.

If the scientist will accept the fact that very delicate highlight and shadow detail are difficult and sometimes impossible to reproduce and use this information in the preparation of the original supplied to the printer, the result will be worth the effort.

Suppose the condition the scientist wishes to illustrate is mostly in the dark portion of the scale of tones, i.e., consists of shadow detail. By the proper selection of negative and paper, by the correct exposure and development thereof, he can increase the contrast in the shadow detail to within limits reproducable by the printing process. In this case no doubt some highlight detail has been lost but we have assumed that the interest was primarily in the shadow detail.

If the interest is in the highlight detail, the same procedure can be followed to obtain a fair degree of contrast in this area, sacrificing somewhat of the shadow detail. If the interest lies in both the shadow and highlight detail, the best results will be obtained from a soft print.

As a guide in determining the degree of softness, it is possible that a general rule tempered with judgment will prove helpful. If the shadow and highlight detail are quite delicate let the darkest tone in these areas be a dark grey rather than black; let the lightest tone be a light grey rather than a blank white. This applies only where and when the detail is delicate. If the tones of a subject are clearly defined the full scale from black to white may be used. If the subject is black and white maximum contrast in the original is desirable.

To stress the importance of suitable originals, mention is made of an instance where careful preparation of the original would have simplified the production of a book and added considerably to its value. The originals to be reproduced were photographs of idols—many of them—and quite small. The bases of the idols, in the photographs, were less than three-eighths of an inch high. Engraved in the bases were characters, Chinese, I believe, and of paramount importance to students and scholars. It was not only desirable to obtain quality prints of the idols but to afford

readers of the book the opportunity to interpret the characters as their knowledge dictated.

In preparing the idols for photographing, the characters had been filled in with a white substance to contrast them with the evident dark base of the idol. However, the photographs indicated that the bases must have been highly polished for in some instances, although the characters were whitened and the bases of a dark color, the background photographed a very light tint. It would seem that there had been a glare of light reflected from the substance of the idol. Many of the characters were obscured by the glare, some outlines being barely discernible in the photograph.

The book would have been of greatly reduced value had the characters been retouched. I understand that there are thousands of characters in the language, each varying shape, curve, delineation forming a basis for interpretation. Even if a retoucher were sufficiently skillful and patient to work up the original lines to within limits reproducable by a process, it could not be claimed that the illustrations were photographic records. It would have been possible to exaggerate the contrast of this highlight detail by copying the original on process film, so timing the exposure that the background of the characters would be greatly undertimed, and, with development, to get all possible density in the characters. In doing this most of the idol would be eliminated from the picture.

Before leaving the subject of originals it may be stated that in the writer's experience, every fine illustration has been traced to good original "copy."

Where the prime interest is in a certain area or section of a picture, it is advisable to inform the printer. He can favor the reproduction of the detail in this section in many cases without sacrificing appreciably elsewhere. A simple method of indicating is to make a tissue overlay, secured to one edge on the back and folded over the front of the print, upon which the area is outlined and notes made.

From the subject of the originals we proceed to the selection of a process.

A process which has been accepted as the most suitable, the most endowed with factors demanded by and necessary to facsimile reproduction, is known as the Collotype process. However,

it is productive of good results only in the hands of skilled craftsmen. This is a statement with which co-workers in Collotype will hasten to agree. An understanding of the complexity of the Collotype plate will bring a realization and an appreciation of the fact.

The purpose of the following is to point out reasons why the process is capable of excellent results, and why it must be done by hands trained to produce facsimile reproductions.

Let us consider what factors are necessary in photomechanical printing to produce a facsimile reproduction. We must have a continuous tone plate which presupposes a continuous tone negative from which the plate is made. This gives us the scale of tone gradation required. We must have definition, sharpness of line or outline. This demands a fine grain. We must have print quality which is a term very elusive of definition but from which is drawn the demand for a finely divided deposit of a bodied ink which results in "depth" and full tone. No print is better than that of which it is made. Colored turpentine will not produce a lustrous black! And the plate must be inked without slur.

We must be able to print on papers whether the surfaces are smooth or rough, plate or antique, laid or wove. Many reproductions must stand the aging of years and the work demands a paper of the finest quality. Also, it has been observed that the quality of a picture varies extraordinarily with the quality of the paper.

It is desirable that the process be economical. It is advantageous to be able to duplicate the plate. It is of utmost importance that the results be obtained without retouching.

Collotype uses a continuous tone negative. There is the wide selection of film emulsions available to choose from in copying the original to obtain the results desired.

The Collotype plate consists of a base upon which is coated the printing emulsion. This emulsion consists of a sensitized gelatin. After the base is coated and dried it is exposed to light through the negative. The action of the sensitizer is to harden the gelatin when exposed to light and it hardens progressively depending upon the exposure. The contrast of the ideal plate is comparable to No. 1 photographic paper. Upon exposure to light through the negative the plate is hardened differentially by the light transmitted by the various densities of the negative. We have a continuous tone plate. After exposure the unacted-upon sensitizer is

removed from the gelatin by washing. The plate may then be dried and exposed to light without "fogging."

If the plate is soaked in water for a specific time, although gelatin swells indefinitely, the swelling curve is such that, for the purpose, an equilibrium is reached in a comparatively short time. As gelatin is hardened it loses its tendency to absorb water and swell. Therefore the image, hardened differentially, will absorb selectively depending upon the hardening of the various tones.

After soaking, the plate is surface dried and rolled up with ink rollers charged with a suitable ink. The ink is retained or repelled in proportion to the quantity of moisture present in the various tones of the image. Due to the absence of surface moisture on the plate, it is necessary to use a very heavy bodied ink. This makes it possible to use an ink high in pigment concentration and well bodied vehicle.

It is necessary that there be a tooth on the surface of the plate to obtain even distribution of the ink. This is easily understood if one considers the difficulty of inking polished glass and the ease of inking finely ground glass.

The tooth of the gelatin plate is microscopic. It is caused by the reticulation of the gelatin during drying and exposing. This tooth forms the "grain" of a Collotype print. It forms the edges of lines, the outlines of tone areas and is the limit of the sharpness or line definition of a Collotype print, the same as the size of a dot in half tone is the limit of definition in tone work.

It will be observed that while the Collotype plate is lithographic in principle it is also intaglio in that the portions which take the ink are depressed. Therefore it is possible to print on rough papers without the blurring and spreading of fine lines which would occur were the lines in relief and printed under pressure sufficient to "press out" a rough paper.

This is the principle of Collotype. The practice is extremely difficult. Gelatin is most complex. Physical characteristics vary by so many causes they defy control. The weather, the thermal history, the chemical content, the pH, all conspire to defeat the worker.

It was stated that the plate was swollen with water. This is the principle. In practice it is soaked with glycerin and water. If it were soaked with water and printed, the image would flatten immediately due to the air drying of the plate or the drying due to the absorption of water by the paper. The glycerin retards the

drying and, being hygroscopic, will absorb moisture from the air if the room is humidified. However, if the humidity of the room is too high the moisture will condense on the plate and mix with the ink and poor results follow. A standard humidity is not practical for it is necessary to vary the humidity depending upon results desired from individual plates.

It is sometimes necessary to adjust the hydrogen ion concentration of the gelatin after the plate is on the press to change its capacity to swell which in turn changes the contrast of the image. It is sometimes necessary to treat with the salt of a heavy metal to harden, or to treat with a dehydrating agent.

The limits are so delicate that all must be done with consummate skill. Knowledge of the controlling factors can be obtained only through many years of research and observation.

In summary, the purpose has been to point out that to obtain the optimum in printed reproductions, too much care cannot be spent in the preparation of the original which is supplied to the printer; to acquaint the reader with a few of the factors which must be present in a process suitable for facsimile reproduction, and that Collotype is endowed with these factors; that most excellent results are obtainable by skillful, careful workers who are guided by research and who are familiar with the requirements of scientific publications; and finally that the process is not costly. In smaller editions it is less costly than other processes.

The illustrations which accompany this article have been printed by Full-Tone Collotype. It is impossible to judge them as facsimile without comparing with the original, but a glance will appreciate the quality; scrutiny will notice the continuous gradation of tone, and microscopic inspection will reveal the grain.

SPECIMEN
Full-Tone Collotype Reproductions

ILLUSTRATING ARTICLE
BY

ARTHUR C. SIAS
Director of Research
THE MERIDEN GRAVURE CO.

Fig. 1. 20 x magnification of a Full-Tone Collotype reproduction showing the arrangement of the ink particles.

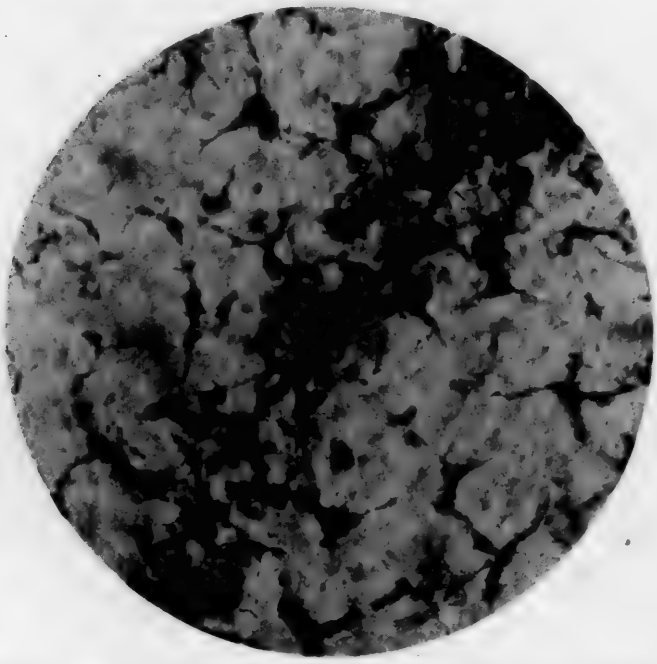

Fig. 2. 200 x magnification of a Full-Tone Collotype reproduction showing the arrangement of ink deposits. Notice absence of screen

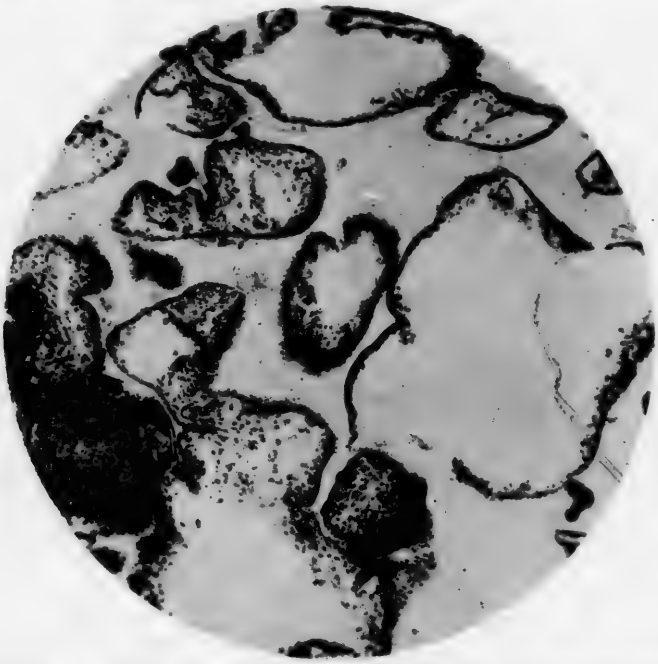

Fig. 3. A Full-Tone Collotype reproduction of a photomicrograph of hydatidiform mole.

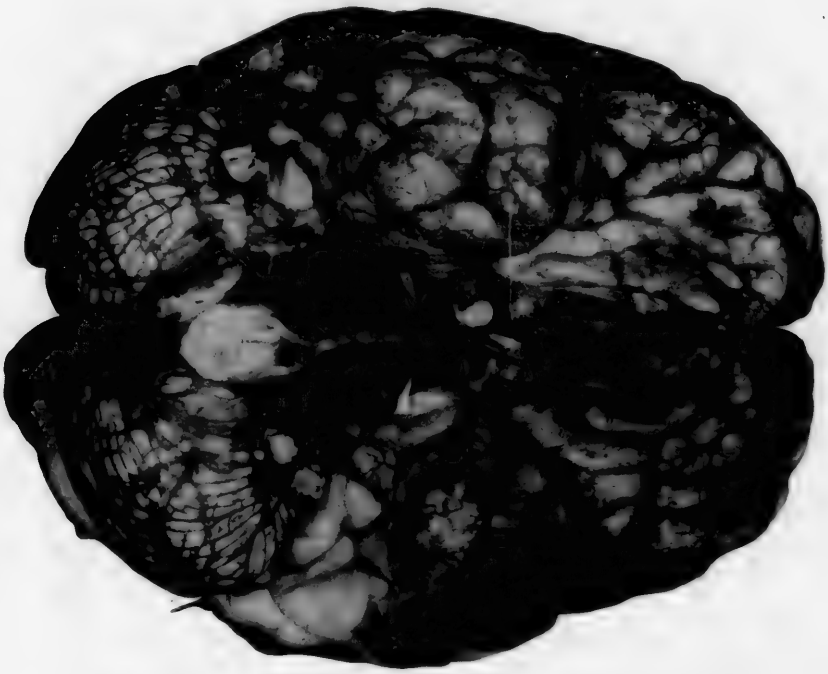

Fig. 4. Diffuse Subpial Hemorrhage. Notice detail in reproduction and absence of screen.

TECHNIC OF FLOWER RADIOGRAPHY

THE BOTANISTS and horticulturists should be interested in the possibilities of further study of plant physiology, morphology, and pathology by radiographic examination. The following is the technic of taking these x-ray pictures as explained by Miss Hazel Englebrecht, of Des Moines, Iowa, and published in *Radiography and Clinical Photography,* May-June, 1932 issue.*

* Reprinted by permission of the editor, Mr. Arthur W. Fuchs.

The method of radiography is relatively simple. An x-ray film is wrapped in one layer of black paper and the flower or plant placed on top of it; exposure holders are not employed. Any modern x-ray apparatus may be used; however, it is necessary to produce x-rays of a relatively long wave length—the so-called *soft x-rays.* This requirement is met by employing a kilovoltage of from 15 to 25, which is obtainable with a rheostat incorporated in the control unit, or an auxiliary auto-transformer placed in the feed lines, which also provides a means of controlling small differences in the primary line voltage.

The additional technical factors include an anode-film distance of 20 inches, 5 to 20 milli-amperes of current; neither screens nor a filter are used. A fine focus x-ray tube should be employed to obtain the maximum detail in the various parts of the plant structure. Owing to the differences in mechanical arrangement in various x-ray apparatus, the time factor must be ascertained by a series of trial exposures.

The films are developed in the usual manner—for 5 minutes in Eastman X-ray Developer at 65°F. When the radiographs are finished, they may be printed on photographic paper as "positives"; or copies made *on film* and "negative" prints produced on paper.

The advancement of flower radiography along all the avenues that appear to be open should provide a remarkable increase in man's knowledge in this field of natural phenomena.

INSECT RADIOGRAPHY*

HUGO FRICKE
The Biological Laboratory
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From the Walter B. James Laboratory for Biophysics

EDITOR'S NOTE: The entomologist and biologist now have at their disposal a new method of insect study that is worthy of consideration. This method is that of radiography. By its use some of the smallest insects may be x-rayed and enlarged by photography for exhaustive study. It is interesting to know that the respiratory apparatus, the digestive system, and parts of the reproductive anatomy, to say nothing of indications of nerve structures, can be shown on these radiographs.

RECENTLY IN *Nature* and *Radiography and Clinical Photography,* several insect radiographs were reproduced from the large number which have been taken at the Walter B. James Laboratory for Biophysics in the last few years. The example herewith reproduced was made this past summer by Messrs. D. M. Gallagher and D. Vexler.

In order to radiograph such small objects, very soft rays are required. They are obtained by operating the x-ray tube at a

* Received for publication October 10, 1932.

low potential, 5 to 15 KV. being usually employed for insects. The walls of ordinary clinical tubes are too thick to transmit these rays and for this reason we have constructed a special tube with a thin window of lithium glass. The insect is placed directly on the film mounted in a box covered with black paper. During the several minutes of exposure a stream of carbon dioxide

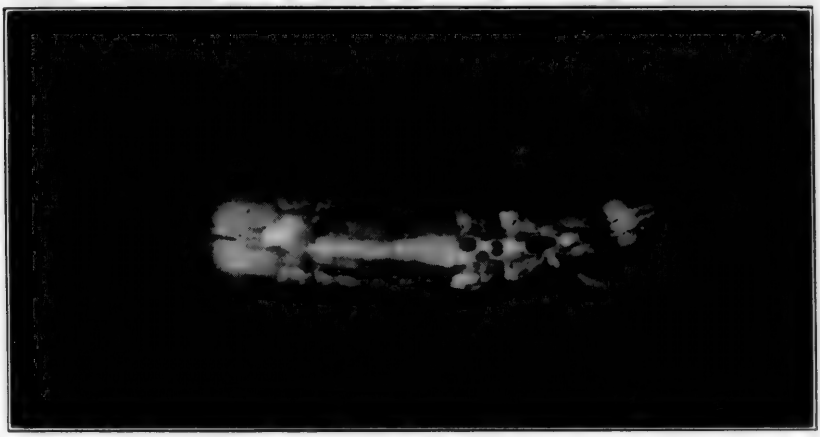

FIG. 1. Earwig. Showing the complete respiratory apparatus, the digestive tube with opaque food material, and parts of the reproductive system. There are also indications of the nervous system, especially the cerebral ganglia and the connections leading to the ventral nerve chain. Magnification, 3x.

mixed with a little ether keeps the insect motionless. The standard dental films of the Eastman Kodak Company are satisfactory for most insects, while for very small specimens we have employed special fine grained plates prepared by the research laboratory of the same firm. A short explanation of the radiograph shown in Figure 1 is supplied by Dr. S. I. Kornhauser of the University of Louisville.

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MICRO AND MACRO PHOTOGRAPHY WITH THE LEICA CAMERA*

WILLARD D. MORGAN

From E. Leitz, Inc., New York, N.Y.

THERE is a tremendous jump from the 8″ x 10″ camera to the Leica Camera which uses 35 mm. ciné film and takes pictures only 1″ x 1½″ in size. During the last eight years while the Leica has been gradually changing the conceptions and working habits of many amateurs as well as scientific photographers there has been established a new demand for reliable information on this subject. Here is a camera which is now being applied to making photographs through the microscope, recording gross specimens, copying subjects under various magnifications, and for all types of scientific photography.

Large size negatives require an increased volume of light where the small Leica double frame size negative may record the same subject with much less illumination. This is a valuable point to consider when photographing living organisms or delicate tissues under the microscope where heat rays may be disastrous with a longer exposure. When photographing medical specimens the objects remain motionless for comparatively short periods, due to breathing, fear, weakness, and temperature changes. When photographing such specimens with the larger sized camera it is practically essential to stop down the lens diaphragm, increase the illumination, and also the exposure time, in order to get the best results. Extreme care must be taken to avoid underexposed, out of focus, or shallow depthed pictures. On the other hand the Leica Camera offers the advantages in using fast lenses of shorter focal length in order to greatly decrease the exposure time and also secure sharp pictures with good detail throughout the subject.

Today when many institutions and laboratories are waving the economy flag there is an opportunity to actually save many thousands of dollars by using the small camera along with the larger photographic equipment. When we realize that one Leica Camera negative may cost only one cent while an 8″ x 10″ negative may amount to 25 cents or more the resulting economy is apparent.

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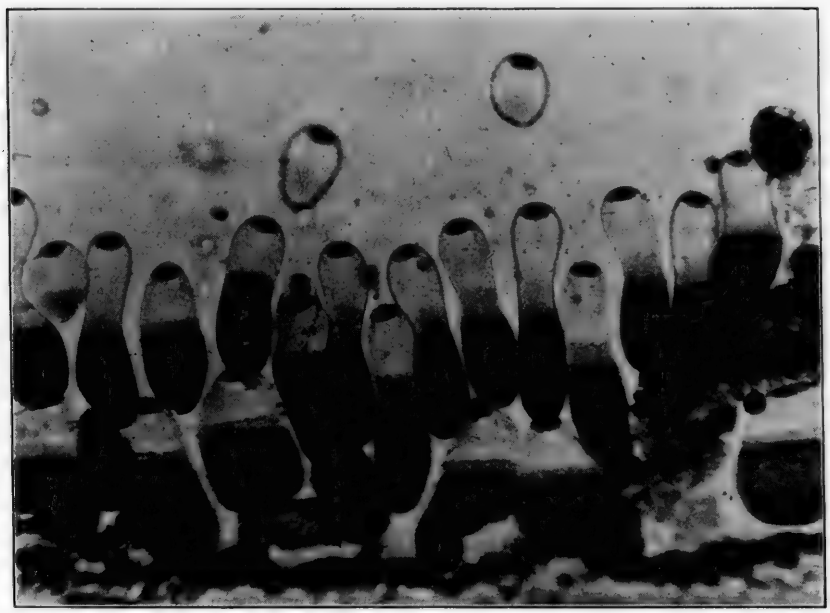
* Received for publication October 18, 1932.

The Leica Camera will take up to 36 exposures at one loading, consequently photographs can be made in rapid succession without losing time for changing plates if the larger type camera is used. Quick movements and structure growths can be photographed in rapid succession.



LEICA PHOTOGRAPH BY E. NEWTON HARVEY

Unfertilized Arbacia punctulata eggs centifruged at 156 R.P.S. (about 10,000 times gravity) and photographed with Leica Camera and Leitz Traveling Microscope No. 4 ocular, with No. 4 objective 115 mm. tube length, 3 seconds exposure.

LEICA PHOTOMICROGRAPHS

When making photographs through the microscope with the Leica Camera the photographer may proceed with one of the following set-ups:

a. Use the Leica directly over the microscope eyepiece together with the special micro adapter collar for this purpose.

b. Use the Micro Ibso Attachment which has a conical tube containing a side viewing telescope, compur shutter for exposures between 1 sec. and 1/125 sec, 10 x Periplan eyepiece, and a threaded base for attaching in place of the interchangeable Leica lens.

c. Use the Sliding Focusing Copy Attachment which holds the Leica Camera in exact plane with a ground glass for visual focusing. When

focus is correct on the ground glass the camera is quickly slid into position for making the exposure.

To make an actual photograph place the specimen under the microscope, adjust the illumination, select the color filter as is generally done for photomicrographic work and focus the microscope to your eye. The point where the specimen is in sharp focus to the eye is usually considered as infinity, or in other words the rays coming from one point of the specimen leave the microscope eyepiece as a parallel bundle of rays. Consequently if we replace the human eye with an artificial eye such as the lens of the Leica it is essential to have the lens set at infinity in order to record the image in exact focus. Note that an observer who wears glasses in order to correct an optical defect of his eye must wear his glasses while focusing the microscope.

The preliminary focusing of the microscope is done with the micro adapter (a) already in position on the draw tube of the instrument. A small clamp band holds the draw tube in rigid position. When focus is correct place the Leica in position and make the exposure.

When using the Micro Ibso Attachment (b) or the Sliding Focusing Copy Attachment (c) focusing can be carried out a little more simply, by viewing the specimen through the side telescope or on a ground glass. In the latter case the ground glass is equal to the exact Leica negative area.

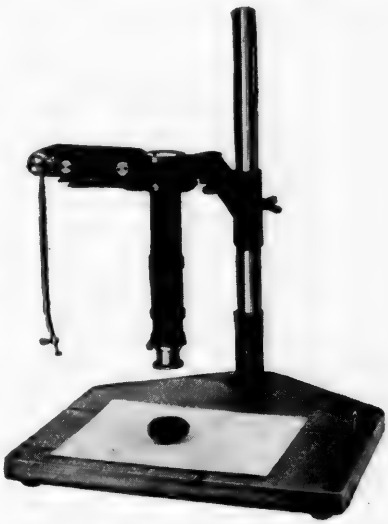
Entire micro slide collections may be photographed on the Leica size negative and then printed onto positive film for projection and special study. Students will find the use of the Leica indispensable for their research work, not only because of the negligible cost but also for the unusual adaptability of this camera for so many laboratory requirements, in addition to photomicrographic work.

LEICA MACROPHOTOGRAPHY

There are many cases where the photographer is called upon to make routine record photographs of specimens under various conditions, such as dorsal, anterior, and posterior views, with different contrast filters, under different magnifications, or possibly during movement. Such conditions require a camera which will produce quality negatives under exacting conditions. With the Leica Camera and the Focusing Copy Attachment which is now

available there is a possibility to record specimens under practically every condition. With the extension tubes placed between the Leica lens and the camera on this attachment, magnifications up to 10 or 20 times may be secured.

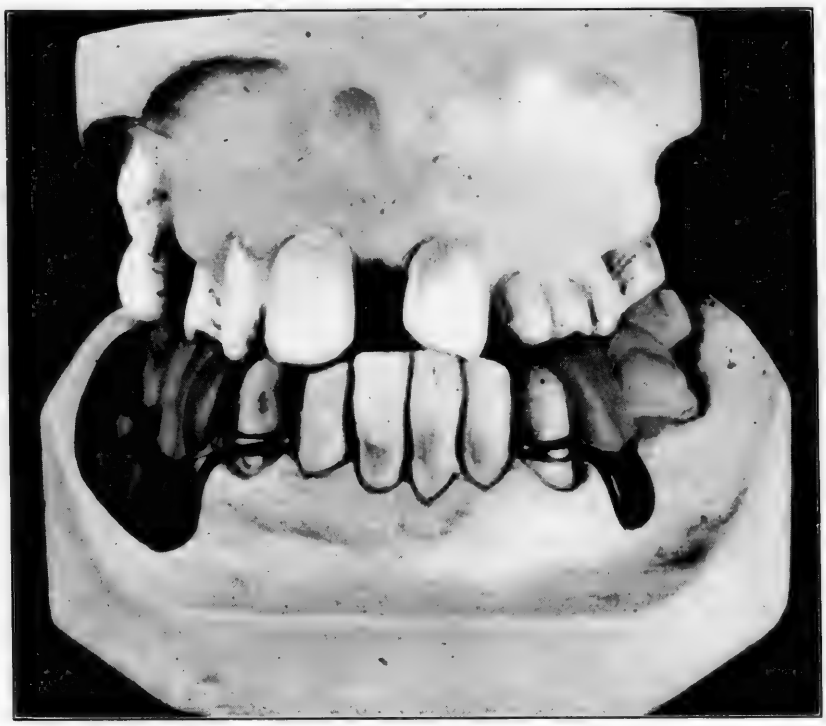
One of the most difficult subjects which I have photographed with the Leica Camera was a six weeks' old human embryo which measured only about 33 mm. in length. This small specimen was first photographed in natural size on the Leica negative by using the focusing copy attachment and one 3 cm. extension tube between the lens and the camera. I designed this attachment over a year ago in order to apply the Leica Camera to a special field of macrophotography in which there was no adequate equipment available for use with the small film camera. Additional negatives were made at various magnifications which including small sections were magnified up to ten times on the Leica negative in order to record the early anlage forms. Here is where it was possible to use the entire roll of Leica film and make 36 valuable negatives showing various positions and magnifications of only one specimen at a total film cost of only forty cents. I was using Perutz Persenso film cut from a 100 ft. roll which can be secured at the rate of eight cents per foot. Eastman or Du Pont Panchromatic films could also be used for this purpose but they would not give the fine grain detail possible with the Perutz or even the Gevaert orthochromatic films.



Leica Focusing Copy Attachment in position with the 3 cm., 6 cm., and 9 cm. tubes attached for securing maximum magnification.

Dental photography is still another field where the Leica Camera can be applied with good results. Dr. Forry R. Getz, a New York dentist, has been using the Leica Camera for a number of years in his work. Dr. Getz is now using the Focusing Copy Attachment for recording many special cases which come under his direc-

tion. For example, he has photographed all his dental castings, examples of bad dentistry, new bridge work for his records, and even natural color photographs of the mouth. The orthodentist can use the Leica for keeping a continual record showing the changes in the mouth formations of his patients.



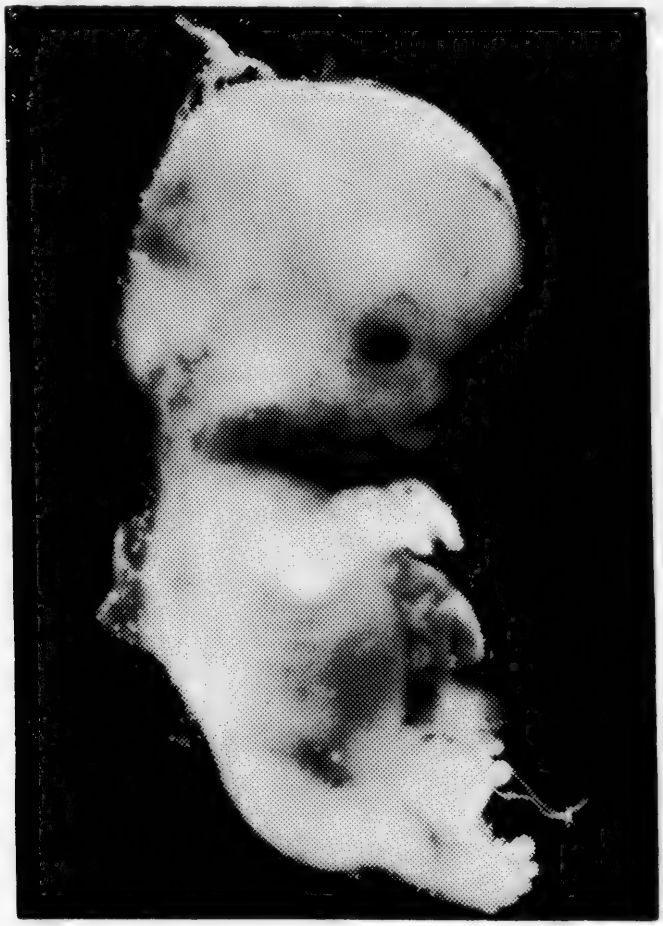
LEICA PHOTOGRAPH BY DR. FORRY H. GETZ

Photographic record of unusual dental case. Photograph made with the Leica Focusing Copy Attachment. Note the extreme depth of focus secured by using the 50 mm. Elmar Leica lens. The specimen measures 2½ inches from front to rear.

The behavior of animals in the laboratory under various test conditions may easily be recorded on the small Leica negative for later study. Here is where the Leica proves to be of exceptional value because it is possible to follow the fast actions of a monkey or possibly a rabbit and secure accurately focused negatives. The built-in range finder on the Leica Camera is coupled with the lens so that continual focus can be secured at any instant the picture is to be made. The short focal length of the two inch Elmar lens

produces a marvelous depth of focus in the negative even when the diaphragm is opened to F :3.5.

X-ray negatives can be copied onto Leica film for projection purposes as well as for making contact paper prints for indexing



Six weeks old human embryo—original size 35 mm. Leica photo by W. D. Morgan using focusing copy attachment with Leica camera.

or for use in making enlargements for special study requirements. As most x-ray films are too large for direct projection the Leica size negative affords an excellent economical method of showing various cases by projecting in the regular Leica double frame size projector.

Many hospitals destroy their radiographic films after a few years as a fire precaution. In this manner many valuable records of interesting cases are lost for future reference. The Leica offers a most economical way of preserving these records by copying them on motion picture film. A roll of 200 feet of this film can be made in negative form for a cost of less than ten dollars. This amount of motion picture film will contain 1600 copies of x-ray films in their reduced form and can be placed in a tin can that will easily fit in the coat pocket. When any particular film is desired for study in the future it may be either projected on a screen from the Leica film or it may be photographically enlarged in print form for study or reproduction in scientific publications.

Leica copy of x-ray negative 24 x 36 mm. exact size of Leica negative.

Leica small film photography is actually pioneering a new field in modern amateur and professional photography. There are seven interchangeable lenses available for this camera and over 200 special accessories to select from in order to apply the Leica to any photographic requirement. Motion picture film is available for every requirement with this camera. By using fine grain developers it is possible to enlarge the Leica films up to 8″ x 10″ and greater when fine grain films are used. This is a camera which will fulfill many photographic demands which confront the individual research worker or the professional photographer.

A SUCCESSFUL ADVANCE IN THE TEACHING OF BIOLOGY

IN THE DEPARTMENT of biology of the Philadelphia College of Pharmacy and Science, Professor Arno Viehoever, head of that department, has created unique and effective additions to the customary methods of collegiate teaching of the biological sciences which have proved unusually successful.

The basis of Professor Viehoever's experiments has been the recognition that the study of biology involves essentially a study of the living. This principle is, of course, generally recognized by biologists, but practical difficulties in the way of its effective use in teaching has compelled much of the study of animal and plant life by college students to consist primarily of the examination of specimens—not of living things—but of the physical remains (usually artificially preserved) of what once were living things.

In an effort to supplement these studies of physical specimens which long have been used in the study of the biological sciences by college students, Professor Viehoever has experimented continuously during the past ten years.

His research and experiments finally focused upon the daphnia, the common water flea. This is an animal which has all of the organs and func-

tions common to most of the higher forms of life. It has also a characteristic possessed by few other animals with similarly complex organs. It is transparent. All of its internal functions and reactions can be viewed in the living animal.

The daphnia in life, however, is no larger than the head of a pin. Therefore the advantages of its transparency in biological studies are more apparent than real, because of the microscopic size of the animal, except when its activities and functionings can be viewed under a microscope. No teacher needs however to be told the limitations of this method in classroom demonstrations.

From time to time photomicrographs are taken to preserve as a permanent record the various stages of the experiments. However, the still photograph possesses few advantages over the dissection and inspection of the physical remains of larger animals.

The original work of Professor Viehoever and his associates has made possible the exhibition of the living daphnia in a size two thousand times that of life so that the actions, functions and responses of this living animal can be viewed simultaneously by a lecture room full of students. Indeed original inventions have made it possible for a lecture room of students not only to see these actions, functions and responses in the living animal, but also to hear them. Experiments in micro-projection and radio amplification have made this possible and practical.

Permanent records of demonstrations with living daphnia also have been made by sound photography. These films are shown regularly in biology classes at the Philadelphia College of Pharmacy and Science.

It is not unnatural that these results should be viewed with enthusiasm by students and teachers alike. In classroom demonstrations all of the functions, actions and responses of the living animal can be shown and explained in an animal which is so transparent that everything that goes on inside it, as well as the external manifestations, are clearly visible.

For instance, the digestive system can be shown dynamically as it exists in life. Therapeutic actions of drugs can be readily and completely shown. Thus, when strychnine is administered to a living daphnia, the quickened heart beat, the enlargement of the heart, the muscular contractions and all of the other internal and external reactions are clearly visible in a size which can be seen simultaneously by an entire classroom.

These developments in the teaching of biology in no way conflict with the advances which have been made in other directions in this field, both in material and in pedagogical methods. Rather they form an effective supplement particularly in those branches of biology in which a study of the living is vital to more complete knowledge of the subject.

Because of the experiments of this character which have been carried on continuously for the past ten years at the Philadelphia College of Pharmacy and Science, it is natural that many students there have chosen biology as the field of their future work.

Let no student who contemplates a specialized study of biology fear that there is only a small field for his talents after completion of his college work. In his book, "Jobs for the College Graduate in Science," Professor Edward J. v. K. Menge, director of the department of zoology at Marquette University, lists more than 200,000 persons in the United States who are today employed in the biological sciences. This count does not include other large groups engaged in pharmacognosy and medical biology. With the advances constantly being made in the field, it is reasonable to believe that the number of people engaged will increase rather than decrease.

PHOTOGRAPHIC TECHNIC

NEW PROCESSES AND EQUIPMENT

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From the Department of Art, School of Medicine, University of Maryland

A METHOD FOR ELIMINATING THE GRAIN IN PAPERS

SOME PHOTOGRAPHERS have found it difficult to make successful copies of photographs that have been printed on rough surfaced papers such as linen finish. This is due to the fact that the rough

FIG. 1

FIG. 2

surfaces or grain of these papers invariably shows in the negative and therefore in the positive. Even when the copy is printed on the same kind of paper as the original this defect is not overcome.

The rough surface or grain can practically be eliminated by placing the original photograph in a shallow tray of water and photographing it while it is completely submerged. Of course, the camera must operate in a vertical position. It is often necessary to weight the four corners of the original to keep it from floating to the surface of the water. Ordinary lead composition slugs used by printers are excellent for this purpose. The lighting source must be flat and even, as that supplied by the ordinary commercial copying board.

In the above cuts Fig. 1 represents a copy made of a print on linen finish paper without submerging the original under water. The lower part in Fig. 1 is an enlargement of the chin and hand of the subject. Notice how prominently the grain of the paper stands out.

In Fig. 2 we have the same photograph as it appeared after being copied under water. The lower part of this cut is an enlargement from the same negative. Notice that practically all of the grain has been eliminated.

It might be said that when the operator desires to obtain the effect as that produced in an oil painting which has been painted with comparatively dry brushes, thereby showing the grain of the canvas, the method used in obtaining the copy in Figure 1 may be worthy of consideration.

This evidently is not a new procedure but it is likely that many photographers are not familiar with its principle.

THE USE OF PAPER NEGATIVES IN BIOLOGICAL PHOTOGRAPHY

UP TO THIS time paper negatives have not been used extensively in biological photography. They are, however, of great value in the making of charts, line drawings, and graphs. The advantage of using paper negatives in this work is obvious, mainly because photographic paper is decidedly cheaper than film.

The negatives may be made by contact, directly from the original, providing no written material is on the back, or may

be copied with a camera by fitting enlarging paper into film holders for use as plates or films. Usually a medium bromide paper is satisfactory. Sometimes Velvet Bromide or even Kodaline is used to compensate for undue contrast or flatness. A contrasty glossy paper serves well for line drawings or graphs. A single weight paper will give better results, and is usually used for general work. Chloride papers are very slow unless one uses either an arc or daylight.

It should be noted that printing through a paper negative requires much more exposure than through a film negative. The use of bromide paper for making the positive by contact will decidedly lessen the time of exposure. Care must be taken in using this paper to cut out the guide light in the printer; otherwise one is apt to fog the positive paper.

The paper negative may be oiled to increase its transparency, but this is not recommended unless the oil is carefully blotted off, as it may cause dust to collect on the negative which is likely to create spots or smears on the prints.

Paper negatives are easily retouched, thereby correcting defects in halftones, highlights and shadows.

THE GRACOPHOT EXPOSURE-DISTANCE METER

FIG. 3. The *Gracophot*

THERE has appeared on the market recently an exposure meter which is apparently one of the greatest improvements in such instruments in many years. This meter combines both exposure and distance in one. It is adaptable for both motion picture and still photography using natural or artificial light.

Detailed information about this instrument may be secured from Burleigh Brooks, 127 West 42nd Street, New York City.

A HOME-MADE PHOTOMICROGRAPHIC APPARATUS

A HOME-MADE photomicrographic apparatus can be made quite easily. A camera with a ground glass is absolutely essential. This camera may be mounted on a suitable support so as to be held over the microscope. A portable drill press stand serves the purpose very well, or separate parts can be used from the press in constructing one's own apparatus.

It is advisable to have the camera so that it can be moved up and down. A sliding platform mount with thumb screws is just the thing. This facilitates moving the camera quite easily.

The lens must be removed from the camera and a light-lock placed on the microscope. These lightlocks can be purchased from any major optical concern.

The lighting can be of practically any nature, such as an arc, a ribbon filament, or an incandescent bulb. If the latter is used, it may be necessary to use a ground glass between the bulb and the mirror on the microscope. This will keep the filament from showing in the picture. A condensing lens placed in front of the light source will help spot the light on the microscopic mirror, thereby giving a concentrated light that is greater in brilliancy.

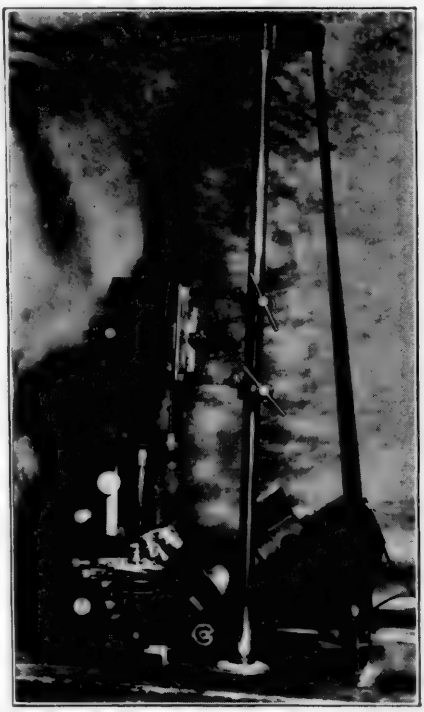
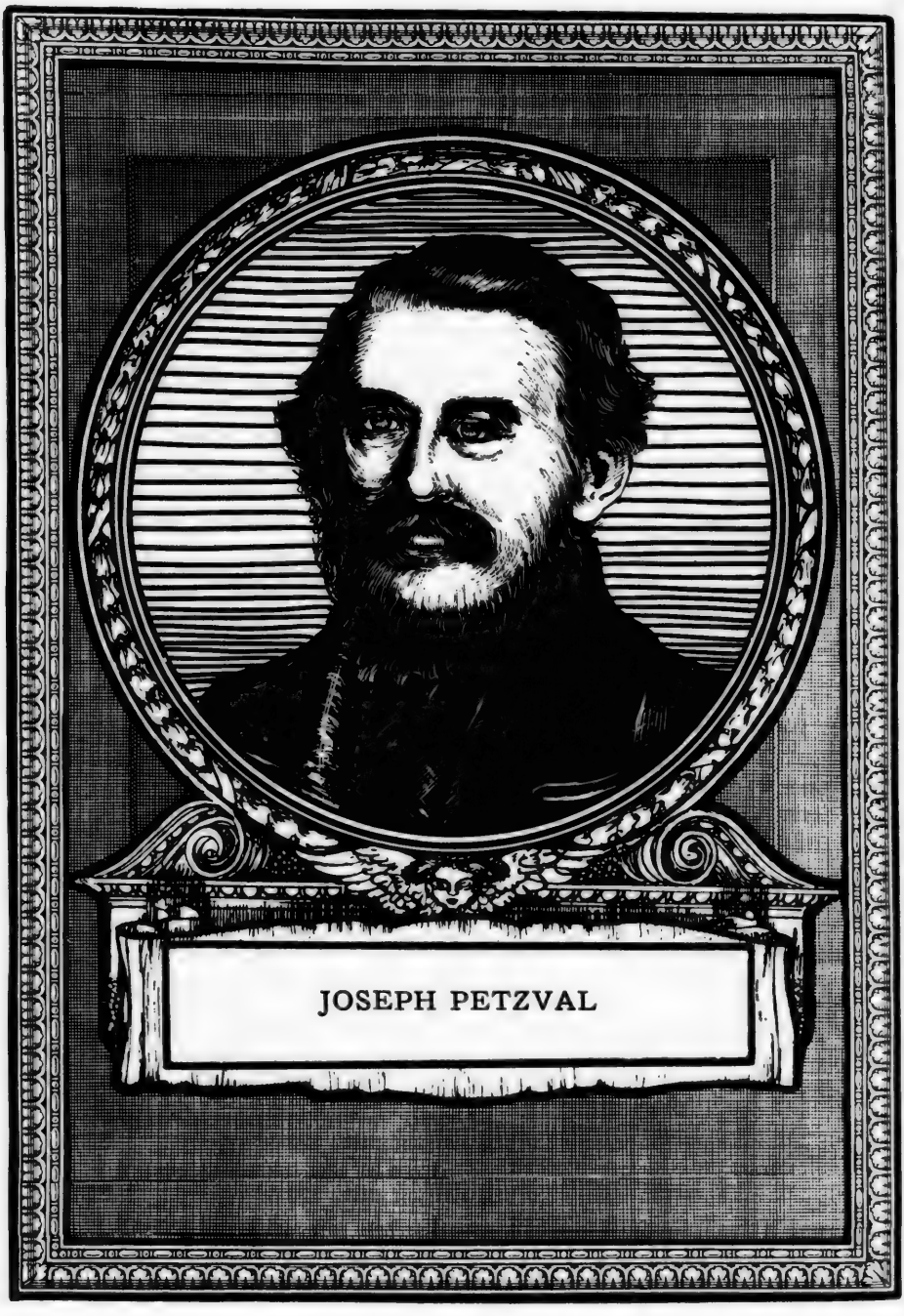


FIG. 4. Home-made Photomicrographic apparatus.

a. Support from portable drill press.
b. Screw for holding camera to platform.
c. Color screen mount on arc light.

This apparatus should be well braced and fastened down on a table or bench that is free from vibration. Figure 4 is an example of such a home-made apparatus.



JOSEPH PETZVAL

PHOTOGRAPHIC HISTORY

Theories of the past become realities of the present and mentors of the future.

THE DEVELOPMENT OF THE LENS

CARL D. CLARKE
BALTIMORE, MARYLAND

From the Art Department, School of Medicine, University of Maryland

LIGHT is the agent that produces in us the sensation of sight. It is emitted by luminous bodies themselves such as the sun and other burning substances. It can be reflected by bodies which do not have the power to emit it themselves. Such are called non-luminous bodies; an example of which is the moon.

Molecules of luminous bodies are in a state of exceedingly rapid vibration. These vibrations, being committed to the ether, which pervades all space, are thus propagated and eventually strike our retina. The number of these vibrations in the unit of time produces in us the sensation of different colors.

The straight line along which light is propagated is called a *ray* and an assemblage of rays constitutes a *beam*.

The substances through which light can be propagated are called in optics *media*. Examples of media are air, water, and glass. These can take shapes that cause rays of light to refract or bend. A typical example of an object that has the power to refract or bend rays of light is a *lens*.

A lens is a transparent substance, usually glass surrounded by curved surfaces so formed that rays of light passing through it are made to change their direction and to magnify or diminish objects at a certain distance.

While it is needless to say that lenses of a fashion were made and used long before photography was conceived it stands to reason that this science had much to do with the development and perfecting of them. Even in prehistoric times some observing individuals evidently noticed the magnifying or reducing powers of lens shaped crystals or quartz.

Archæologists have unearthed lens-like crystals all around the Mediterranean and have fixed the dates between 3000-2000 B.C. and 300 B.C. for the advent of lenses. Glass beads that have magnifying powers have been discovered in Egyptian tombs that are three thousand years old.

W. Jerome Harrison, in his book, *A History of Photography,* claims that a lens was found in Nineveh, a city that was destroyed a thousand years before Christ. This lens at present is in the British Museum.

Aristophanes mentions the use of a burning glass to destroy the writing on a wax tablet in about 424 B.C. Pliny later described glass and crystal balls filled with water. It is well known that Nero observed objects through a lens-like jewel or precious stone.

Seneca in 63 A.D. wrote the following: "Letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water." Euclid wrote of curved mirrors being used to magnify objects.

It was not until the middle ages that the manufacture and properties of simple lenses were understood in Europe; yet the fact must not escape us that according to legend, spectacles were worn in China at the time of Confuscius, about 500 B.C. In 1278 Marco Polo reported the extensive use of them throughout the Chinese Empire.

A real step forward was taken in 1307 when Bernard de Gordon first mentioned the use of convex glasses as spectacles. In 1500 Leonardo Da Vinci investigated and used the properties of concave and convex lenses. Leonardo was familiar with the camera obscura but we have no proof that he fitted it with a lens.

A lens was not fitted to the camera obscura until 1568, according to published reports. At this time Daniello Barbaro published his *La Pratica della obscura Prospectiva* at Naples which mentions this fact. It is interesting to note that Barbaro, in speaking of this, directs that "an old man's glass convex on both sides, not concave, like the glasses of youth with short sight," should be fixed in the hole in the window, and all light stopped out except what comes in through the lens.

In 1585, seventeen years later, Giovanni Battesta Benedetti again mentions the camera obscura with lens. This was brought out in his book of mathematical and physical observations, which

was published at Turin. The lens used by these men was planoconvex in form. Kepler took up the study of the camera obscura about the beginning of the seventeenth century and investigated it thoroughly both from a theoretical and practical standpoint. He was the first to perceive the advantages of a compound objective composed of concave and convex lenses. In 1611, Kepler published his *Dioptrice* which deals with the principles of refraction of image formation and the properties of various forms of lenses and their combinations. He tells of the disadvantages of the planoconvex form in regard to the small field. He also tells of the advantages of the use of the concave lens with the convex.

Kepler deserves much credit for placing the optics of the camera on a firm foundation. Unfortunately he has not received the attention he is due.

Not only did the early photographer have to be his own cabinet or camera maker and chemist or plate maker, but he had to also be his own optician or lens maker. The following abstract is from a letter of Joseph Nicephore Niepce to his brother Claude, which will give some idea of these early experiments with lenses:

> You have seen that I had broken the object-glass of my camera; but that I had another which I hoped to be able to make use of. My attempt was a failure; this glass has a shorter focus than the diameter of the box, and so I could not make use of it. We went to town last Monday; I could only find at Scotti's a lens of longer focus than the first, and I have had to lengthen the tube which holds it, and by means of which the exact focus is adjusted. We returned here Wednesday evening; but since then the weather has always been dull, preventing me from continuing my experiments; moreover, I am too worried and fatigued with paying or receiving visits to be able to give much attention to them. I would prefer, I assure you, to live in a desert.
>
> When my object-glass was broken, no longer being able to make use of my camera, I made an artificial eye with Isidore's ring box, a little thing from 16 to 18 lines square. I had, luckily, the lenses of the solar microscope, which, as you know, belonged to our grandfather Barrault. One of these little lenses proved to be exactly of the focus wanted; and threw a picture of objects in a very sharp and life-like manner on to a field of thirteen lines diameter.
>
> I placed this little apparatus in my workroom facing the open window looking on to the pigeon-house. I made the experiment in the way you are acquainted with, my dear friend, and I saw on the white paper the whole of the pigeon-house seen from the window, and a faint impression of the window frame itself which was not exposed to the sunlight. One could distinguish the effects of the solar rays in the picture from the pigeon-house up to the window-sash. This is but a very imperfect experiment, but the images of the objects were extremely minute. The possibility

of painting by this means appears almost clear to me; and if I am able to perfect my process, I shall hasten to respond to the interest which I know you will take in it, by imparting it to you. I do not hide from myself that there are great difficulties, especially as regards fixing the colours, but with work and patience one can accomplish much. What you had foreseen has proved true. The ground of the picture is black, and the objects are white, that is to say lighter than the ground.

Due to the fact that there was no great demand for lenses, the early investigators and experimenters in photographic processes had trouble in obtaining them specially made for purpose of giving a suitable image. The lenses available were generally made for telescopes. They were ochromatic lenses of two cells, one of flint glass, the other of crown glass cemented together with Canada balsam. These lenses were made for the purpose of giving a good image of the small area as seen through the eye-piece of a telescope. Naturally, their shortcomings were many when an effort was made to use them over a large area. The center of the image would be sharply fixed but as it neared the edges it rapidly faded into confusion. By reversing this lens the center of the image became degraded but the edges were somewhat improved. By mounting the lens in a tube containing a diaphragm in the outer end at a distance about equal to the diameter of the lens, the defining power was increased. The intervening of this diaphragm cut down considerably on the speed of the lens.

The long exposure made necessary by the small aperture was of great importance in the early development of photography because the sensitive materials used were decidedly less sensitive than they are at present. The fact that a greater amount of photography at this time was portraiture added considerably to the difficulties after the novelty of obtaining sun pictures had passed. It was no easy matter to get the subject to sit for an exposure of a few minutes.

This difficulty was at last overcome by Professor J. Petzval, a mathematician at the University of Vienna, who calculated a new lens. This lens was composed of four cells and operated at a larger aperture dividing the cells in units of two's. It gave good definition at full aperture and shortened the exposure to one eighth of the old type lens. Two years after the Daguerreotype, which was the first practical photographic process, this lens was manufactured for general use by Voigtlander of Vienna.

The new lens of Petzval was specially intended for portraiture

and was not adopted for general views such as a wide expanse of country. It did not show detail at the margin of the plate with the same sharpness as at the middle. For these reasons the old lenses continued to be used. Although improvements were made in both lenses there remained for a long time two kinds of lenses, portrait lenses and view lenses. The portrait lens was rapid and gave sharp definition in the center of the plate but fell off towards the margins; while the view lens was slow it gave good definition over a large angle of view.

In 1866, a lens intermediate between these two was introduced that enjoyed a greater popularity than any known up to this time. It had two compound lenses with a diaphragm between. Steinheil called it an "aplanat" because it would work satisfactorily at full aperture. Dallmeyer called his lens a "rapid rectilinear" because the curvilinear distortion was corrected. Ross, in 1874, named his "rapid symmetrical" because the lenses or cells on either side of the diaphragm were exactly alike, their construction being symmetrical.

While these lenses were called rapid view lenses they might just as well have been called slow portrait lenses. Due to the fact that they were made in various degrees of rapidity, the old distinction between portrait and view lenses gradually passed away.

Due to the fact that opticians had only very few kinds of glass at their disposal their power to improve optical instruments was quite restricted. An attempt to make new kinds of glass is not a task to be lightly undertaken. It meant the use of new chemicals and long tedious experiments to discover the direction in which the properties of glass would be changed by the use of these new constituents. However, in 1881 experiments were started in this direction by Dr. O. Schott and Professor Ernest Abbe in Jena. Eventually, these optical glass pioneers were assisted by the German government. The final outcome of the investigation was the celebrated optical glass works at Jena. Here, a hundred or more varieties of optical glasses may be obtained and an optician who wants a glass of any other special kind may, within reasonable limits, rely upon having it prepared for him. It took opticians and mathematicians many years to make effective use of these opportunities for improving objectives. The firm of Zeiss was a pioneer in this undertaking.

With the discovery of new kinds of glass a revolutionary progress in the improvement of ordinary photographic lenses took place. All lenses up until this time suffered greatly from astigmatism and curvature of field, these defects being reduced only by the use of a small diaphragm which naturally reduced their speed tremendously. The new glass corrected these aberrations greatly and many lenses were put on the market. Among the first to gain any degree of appreciation was the double anastigmat of Goerz which was calculated by Dr. E. von Hoegli and introduced in 1893. Within a few years nearly all opticians of note had issued anastigmats as calculated by their mathematicians which varied greatly in their general characteristics and construction. One of the most highly appreciated was the "protar" of Zeiss. The chief characteristic of these modern lenses is the fact that they give good definition at full aperture over a much larger area of the plate, other details being the same.

As photography increased in popularity, faster and faster moving objects came within its scope. Then came the desire for faster lenses with the same covering power. In the second decade of the nineteenth century, the aperture of the general purpose lens was increased to F:4.5.

The phenomenal rise of cinematography and particularly amateur cinematography has stimulated further the production of rapid lenses. The old Petzval lens was called upon to take a new lease on life as a projection lens. Its aperture ratio was increased to F:2 or F:1.8. Later Taylor, Taylor & Hobson, by further modifications of design, increased the ratio to F:1.5 and F:1.3.

The old limitations of curvature of field still handicaps the taking lens so that cinematography still depends on the latest developments of the anastigmat. However, today we have perfectly good lenses that have an aperture of F:2, F:1.8 and F:1.4 that are available in small sizes required for cinematography. For ordinary photography, lenses with the aperture of F:2.5 and F:2 are available.

Not only have lenses been made faster and corrected for spherical aberration, but they have also been corrected greatly for color aberration. Progress in optical design has been periodic since 1881. Each great advancement has been shown to be due to the improvement in glass. With the introduction of new glasses, its possibilities have been painstakingly explored and developed. However, the

millennium of lens perfection is not yet reached. Some new process will be perfected, some mathematical or physical theory will become a reality which will greatly add to the accumulated knowledge of lenses.

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Due to an oversight in the September issue of the JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION proper credit was not given to Mr. C. B. Neblette's excellent book *Photography—Its Principles and Practice.*" Facts in the article "The Development of the Camera Obscura," were largely drawn from this book.

OPEN FORUM

THE LIFE OF PROJECTION LAMPS

GENTLEMEN:

I note, on Page 19 of the JOURNAL (for September) an illustration showing the tilting of a Bell and Howell 16 mm. projector so that the optical system of the projector will function as a means for the microscope substage illumination. In my opinion, this would not be a very satisfactory procedure from the point of view of economical operation of this projector, for the reason that the life of the projector lamp is very short when the lamp is tilted very far from a vertical position. The filaments in these lamps are subjected to an extremely high temperature and must be burned in a vertical position else the filament will sag, the bulb blacken, and the lamp itself be very likely to "bulge" because of the uneven heating effect. All in all, the use of the projector in this position would be inadvisable, especially when the same effect could be achieved by placing the projector upright on some sort of shelf below the apparatus so that the center line of its optical system would strike the substage mirror of the microscope and be reflected at right angles.

I trust you won't construe this as criticism of the JOURNAL, which I

consider excellent, but rather as a hint which may render more efficient and lasting the 16 mm. apparatus with which we are so familiar.

Yours truly,

RUSSELL C. HOLSLAG (*Signed*)
Technical Consultant
Amateur Cinema League, Inc.

16 MM. VERSUS 35 MM.

GENTLEMEN:

I have read with much interest Mr. Osborne Heard's analysis of equipment and methods for time lapse motion photomicrography appearing in the September issue of the JOURNAL.

The comprehensive nature of this survey should make it of value both to workers already engaged in this field and to those who contemplate the purchase of equipment for this type of work. For the latter, however, I think the author's comment upon the value of 16 mm. equipment will be misleading. It is not really particularly "unfortunate" (as the author states) that 16 mm. pictures cannot be enlarged to 35 mm. film without loss of resolution. It is only for large audiences that there is any real need for the large film. For audiences of a hundred or more, 16 mm. picture projection is entirely satisfactory. For classroom demonstration and for purposes of research, 16 mm. equipment is admirably suited.

Since it is only for presentation to audiences of theater proportions that 35 mm. pictures have any real advantage, other relative merits of the small and large films should be carefully considered by anyone undertaking to equip for motion photomicrography. I have mentioned below some of the more important matters for consideration.

Cost.—It is difficult to make a generalized comparison of initial equipment cost. Comparing catalog prices for complete equipment one arrives at the conclusion that a 35 mm. time-lapse photomicrographic outfit may cost from five to ten times as much as the complete 16 mm. equipment to do the same job. However, if one intends to purchase a camera and to build his own equipment, the 35 mm. camera cost as Mr. Heard points out may be small, and the auxiliary equipment construction costs are not greatly different for the two sizes. Rather more definite data can be given for the relative operating cost. A 35 mm. negative and first print will cost for material and processing charges at least five times as much as the 16 mm. equivalent.

Portability.—The 16 mm. camera and its auxiliary devices for photomicrography can be made in a form much more easily portable than a 35 mm. outfit. The same statement is in general true of projection equipment of high quality for the two sizes.

Processing.—Ciné Kodak film is processed at a large number of stations distributed throughout the country. In general, 16 mm. results will be returned to the photographer much quicker than a first print could be obtained from a commercial processing laboratory.

Quality of Results.—The resolution obtainable in projected images of 16 mm. and 35 mm. film is about equal.

On page 13, Mr. Heard makes a statement regarding the beam splitter for use with the Ciné Kodak photomicrographic outfit. I should like to point out that provision is made for negative oculars in the Bausch and

Lomb apparatus and that compensating negative oculars for use with apochromatic objective also are available.

In connection with driving mechanisms it might be mentioned that the Bausch and Lomb outfit always has been equipped with a synchronous motor. This is not a "recent application" for which Rosenberger is responsible. In passing it might be mentioned that synchronous motors may be used with alternating frequencies other than 60 cycle. Apropos of lighting, critical illumination may be obtained with spiral filament lamps if a relay lens system is used by allowing the substage condenser to image the lamp condenser on the slide.

Please allow me to congratulate you and your society upon the excellent first issue of your JOURNAL. I feel that its pages will prove a medium for the discussion of many subjects of high importance to the technical photographer.

Yours very truly,

CLIFTON TUTTLE (*Signed*)
Physics Department
Research Laboratory
Eastman Kodak Co.

AN ANSWER TO MR. TUTTLE'S LETTER

GENTLEMEN:

In reply to Mr. Tuttle's criticism of my article on time lapse photomicrography I feel that he missed the point of my review. The purpose of the review is stated in the second paragraph quite clearly and I am at a loss to understand why my critic has duplicated, in a sense, what Bausch and Lomb Optical Co. have so adequately described in their brochure of the device. Undoubtedly the 16 mm. has its place in the field of time-lapse photomicrography but it is not sufficient for all purposes as Mr. Tuttle would lead one to believe. The presentations of research results do demand at times theatre proportions! It goes without saying that any reduction, reversal, or transfer of a photomicrographic image is deleterious.

The cost of equipment cannot be generalized, as Mr. Tuttle indicates, but he greatly overestimates the cost of processing. We use as negative material 35 mm. Positive News Stock for tissue growing *in vitro* at a cost of one cent per foot. The total cost per foot, ready for projection, is slightly less than five cents when the work is done by the Alpha Studio of this city. Processing of test strips is readily carried out in any laboratory and no delay is experienced whatsoever.

The quality of the results are not comparable, especially when film resolution and magnification are seriously considered. The beam splitter as originally described by Mr. Tuttle carried neither negative nor compensating oculars. These features have been added to the present outfit of Bausch and Lomb. Apparently credit for the first use of synchronous motors was erroneously given to Mr. Rosenberger.

The superiority of 35 mm. devices is unquestionable. Why not ask the photomicrographer to junk his 8″ x 10″ equipment for the 3¼″ x 4¼″ size? Every worker appreciates the latitude of the larger size and takes advantage of it.

"Critical illumination" according to the definition as given in Hinds and Randle's "Handbook of Photomicrography" cannot be obtained with

a spiral filament and still have an evenly illuminated field. A contribution from Mr. Tuttle on this phase of photomicrography will be appreciated by every worker.

In summing up Mr. Tuttles' criticism I feel that he has contributed a commercial *faux pas* and has not seriously considered the "home made" devices that pioneered the way for the splendid devices made by Eastman Kodak and Bausch and Lomb Optical Companies.

Sincerely,

OSBORNE O. HEARD (*Signed*)
Carnegie Institution of Washington
Department of Embryology

BOOK REVIEWS AND ABSTRACTS

By JAMES R. DUNLOP, JR.

The Motion Picture Cameraman. E. G. Lutz. 248 pages, profusely illustrated with drawings by the author. Price $3.00. Charles Scribner's Sons, publishers.

"The Motion Picture Cameraman" contains much valuable information about general camera work, trick cinematography, lenses, slow and fast motion pictures, time-lapse cinematography, micro-cinematography, the making of titles and animated cartoon work.

This book deserves a place along with the best photographic references. In plain language, the author clarifies many important points in that vast field of cinematography that have been considered difficult and confusing.

Such questions: What are ghost pictures? What is a cross dissolve? How are dual rôles perpetrated upon the screen? How are animated cartoons made? What is spherical aberration? What is the difference between long and short focus lenses? At what angle should the shutter of a motion picture camera be set? And many more, are answered thoroughly and correctly by Mr. Lutz.

The many illustrations help immensely in explaining those processes so hard to portray by the written word.

Animated Technical Drawings. J. A. Norling. Journal of the Society of Motion Picture Engineers; Vol. XI, No. 31, 1927.

In this article Mr. Norling presents a comparison between the animated technical drawing and the animated cartoon, giving the differences between the two and the advantages of the technigraph in business and as an educational medium. The author writes: "The animated technical drawing or technigraph is a recent development which has grown out of the animated cartoon. Its chief use is to illustrate by means of motion the operation of devices and machinery, while providing in text and action technical descriptions of the same, and in addition it finds a steadily increasing use in other phases of that type of motion picture which is classified as 'educational.'"

APR - 1 1933

The Journal of the Biological Photographic Association

Official Publication of the Biological Photographic Association

VOLUME I NUMBER 3

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March, 1933

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THE PURPOSE of this Journal is to keep the biological photographer posted in the latest developments in photographic technic, and the proper use of equipment and materials in relation to the biological sciences. It will contain articles by authorities in the fields of biological photography. They will tell, in simple language, how to obtain what are ordinarily considered difficult pictures in the easiest possible manner. They will discuss new equipment and its uses. The Journal will have pictures and articles on advanced photographic apparatus constructed by the research workers in the photographic departments of the foremost American and foreign Universities, including Medical and Dental Schools.

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Journal of the
Biological Photographic Association

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INDIVIDUALS interested in Photography as applied to scientific research felt that a convention for the exchange of ideas and information would be of great value, thus, on September 11, 1931, at the Yale University School of Medicine, the Biological Photographic Association was formed.

The object of this Association is to further the study of Photography in relation to the Biologic Sciences and improve its technic.

Anyone whose duties include Photography of Biologic subjects shall be eligible to active membership and shall be entitled to all the privileges of the Association. All others who are interested in such photography shall be eligible for associate membership. They shall have all the privileges except to vote and hold office.

The annual convention of the Association is held in September at different cities of the United States and Canada that have been decided upon in advance by the Association.

The Association maintains an information bureau and any member seeking information regarding this particular field of photography has the privilege of writing to the Secretary who will refer his request to the person best able to answer it.

All papers presented at the annual meeting together with the discussions will be published and mailed to all members of the Society through the medium of its Journal.

An organization of this kind will not only bring together men of similar interests for the exchange of ideas and the discussion of their various problems, but also stimulate research among its members.

The application blank below is for your convenience in becoming a member.

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VOLUME I *March, 1933* NUMBER 3

The Journal of the Biological Photographic Association

EDITORIAL

A Traveling Biological Photographic Exhibition of Prints

The Biological Photographic Association is undertaking the organization of a number of traveling exhibits of work that has been done by its members. Any member of this association who wishes to see what other members are doing in their respective institutions or professions may write to the secretary, Miss Eleanor Cooper, Department of Photography, School of Medicine, Yale University, New Haven, Conn., and request that an exhibit be sent to him. This exhibit will be sent without charge. Postage will be paid for transportation to you, however, it will be necessary for you to pay the postage to the next member that desires to see the exhibit.

All members of the association are requested to please furnish examples of their work to be used in these exhibits. This is an exceptional opportunity to show others your outstanding photographs and in return you may see what other members are doing along the same lines of endeavor. If you are having trouble with certain types of work write to the association for information, or to one of its members whose work in the exhibit shows that he has solved the problem.

As a matter of keeping the photographs in the exhibit of a uniform size the association requests that you make your prints on 8″ x 10″ printing paper from any size negative. For instance, in using a 4″ x 5″ negative, print this in the center of the 8″ x 10″ piece of paper. Be sure to use a mask around the negative so that the entire border of the 8″ x 10″ piece of

paper will be left white. Any size negative up to 8″ x 10″ can be contact printed on the full 8″ x 10″ sheet of paper. Enlargements from smaller negatives to any size up to 8″ x 10″ are also most acceptable.

The association wants all pictures of this uniform size so that the entire exhibition can be bound in loose leaf book form. Do not trim the paper smaller than its original size.

The following information must be written in pencil on the back of each picture:

Name of photographer
His address
Diagnosis or title of subject
Plate or cut film used
Camera used
Exposure used
Diaphragm opening used
Filter used (if any)
Lighting used
Development
Remarks

When these prints arrive at the headquarters of the association they will be backed with Holliston mounting cloth and hinges provided for binding so they will not be broken or torn. They will then be numbered and the information as stated above will be typed on a printed paper and pasted to the back of each print.

Those wishing to contribute prints to this exhibit please send them to the headquarters of the association, Department of Photography of the School of Medicine, Yale University, New Haven, Conn. Also those wishing to receive the exhibits may do so by communicating with the same address. Libraries, institutions, museums or individuals that are non-members of the association may receive these exhibits for a cost of five dollars and keep each for two weeks time. Postage will be paid one way only.

Institutions or individuals that are members of the association may have their own private exhibit provided they submit twenty-five or more acceptable prints with the information required. Such prints will be circulated in loose leaf book form just as the combined exhibit.

THE USE OF ANIMATED DRAWINGS IN MEDICAL MOTION PICTURES*

K. K. BOSSE, B.S.

Loucks and Norling Studios, New York

The field of medical animation, broadly speaking, may be divided into two main parts: The graphic representation of natural processes and of technical procedures. Natural processes include every conceivable form of change or motion, whether of a purely physical nature, such as the contraction of a muscle, the vibration of a vocal cord or the peristalsis of a viscus, or, on the other hand, changes and movements involving physiological activities, such as the functioning of a secreting cell or of a part of the nervous system. Even descriptive anatomy, sometimes regarded as a "static" subject from the motion picture point of view, can in the hands of the animator be presented to the student in an entirely new and striking manner.

Technical procedure will readily be understood to include every form of manipulation and instrumentation, from methods in experimental physiology to the most highly specialized forms of surgery. Although there are among medical teachers those who advocate the "all-animation" film, it is not intended that animation should set itself up as a rival to straight photography. Stop-motion and straight micro-cinematography have produced results, whose excellence and instructiveness are beyond dispute. Straight cinematography of gross clinical and surgical subjects has been equally successful. As long as an object can be placed before a camera lens, resourceful photography can succeed in obtaining its record. But no camera can reproduce what it cannot project upon a film, nor is it practical in the face of severe technical obstacles, nor can it, by itself, generalize or form abstractions from actuality.

Individual phases of natural processes, such as diapedesis and phagocytosis, may be photographed directly at the expense of much painstaking laboratory work, but by what simple cinematographic process could these two be demonstrated in a connected sequence, in their entirety and free from all that is adventitious and superfluous? Actual cinematography cannot visualize the ultimate processes of respiration, nor of the complete circulation of the blood, nor the passage of a nerve impulse

* Received for publication November 16, 1932.

along its path. One example of a more specialized character: the movements and distortions of the uterus and the adjacent structures during retroversion and total prolapse, as seen in sagittal section, cannot be demonstrated other than by animated drawings. Examples such as these are past enumeration.

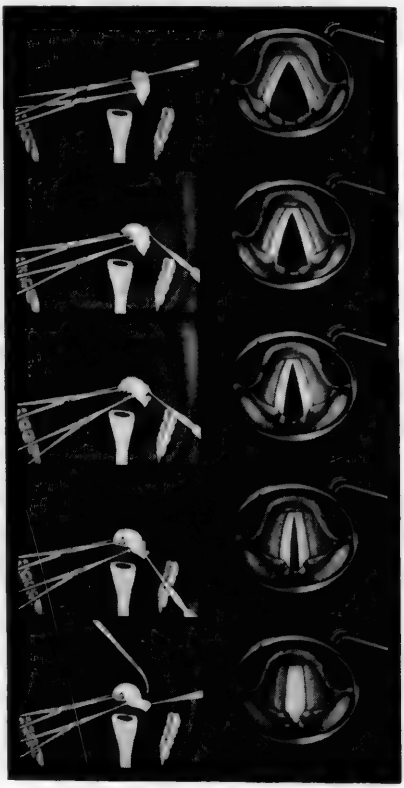

FIG. 1. *Left:* Removal of tonsil. *Right:* Animation of the vocal cords

Just as the textbook must supplement its pictures of gross or microcsopic anatomy with diagrams and schematic drawings, so the medical motion picture must enhance its own value by diagrams of an infinitely greater effectiveness in the shape of animated drawings.

Whether silent or with sound, the film is primarily a story told in pictures, or, in our case, a lesson told in pictures, and with it, the animated schema, by its very nature, is bound to play a more complete rôle than the schematic drawing plays in the textbook.

Animated drawings play possibly even a more important part in film depicting technical procedure. Experimental physiology, diagnostic methods, instrumentation, medical and physical treatment, surgery, etc., furnish an abundance of material that can be made clear to the student by motion pictures.

In filming any of these subjects, phases are encountered constantly which find the camera inadequate and where animated drawings must make good the deficiency. Films of the technical type belong more strictly to the medical field, while those of natural processes belong more properly to that of general teaching.

It is unfortunate that the term "Medical Film" has come to connote in the minds of many the purely surgical film. It is true that animation lends itself admirably to surgical procedure,—even to the point of the "all-animation" film. If, during an operation, the surgeon's hands or instruments enter a cavity, they cease to exist for the camera. The animated outline can supply the deficiency. Minute but important details of procedure either may be beyond photographic possibility or may be lost to the camera through some inadvertency and regard for the patient may prevent repetition. Again the animated drawing offers the remedy. Animation offers a solution where direct operating room photography is looked upon as a possibility offering risks of infection. But the most important function of animation in the surgical picture is its ability to state underlying technical and biological principles clearly and in a natural, logical order; a result seldom or never obtainable by direct photography. Important and desirable as all this may be, it is nevertheless necessary to be reminded that surgery is only one of the many medical subjects suitable for cinematography.

The first major attempts to produce medical films on a large and practical scale, concerned themselves almost exclusively with surgical subjects. This same type of subject has ever since been the favorite not only for the medical amateur photographer but also for the author demanding professional production for extended use. But it is to be borne in mind that animated description of surgical procedure is but one of the many topics of medical teaching. The sponsor of a film should, for the sake of the success of his production and for his own satisfaction, select a subject of a scientific interest that is widespread and promises to be as lasting as possible.

A discussion of the value of animated drawings would be incomplete

without mentioning some of the requirements for a well-constructed and properly balanced film. Any film, to be successful, must obey certain principles, well understood by motion picture technicians, but not so well appreciated by the amateur. Some of these principles apply with even greater force to the teaching film than to the entertainment film.

The story—or lesson—must be told in a manner that will hold the attention and will carry out the development of its message easily and logically. This means the building up of the theme through sequences that flow into each other smoothly and without attention-distracting breaks. The length of the film must be commensurate to its content, i.e., picturisation of any given phase must be neither too protracted nor over-crammed with material. Flagging interest and boredom on the one hand and failure at understanding on the other, are the penalties of these faults. Scenes should be held on the screen long enough to "register" properly, and motion, whether natural or animated should not be hurried or jerky. These and similar rules should appear sufficiently obvious, but violations of those mentioned constitute the most common faults of the amateur medical film. At the present stage of its development, the medical amateur film has not had a chance to establish very many criteria of quality for films in toto. The high degree of excellence of purely cinematographic performance has been mentioned and while there are films whose value depends exclusively upon a few photographic high spots, there are altogether too few of those which, as a whole, present a well told lesson or succeed in making the most of their picture material. Too great concentration of interest on some particular phase or detail on the part of the author would seem to account for this type of unbalance.

Medical teaching films, professionally produced, are steadily increasing in number, as recognition of their lecture room value increases and opportunities for their display multiply. High standards of quality have been established and production proceeds on lines as carefully planned as for the most ambitious entertainment pictures. Facilities of the professional studios, both as regards to equipment and personnel, must necessarily surpass those of the average amateur. There is no reason why the amateur following the essential rules of production could not show results which with very little professional assistance, would place his product at the disposal of the larger field of usefulness which the professionally produced teaching film is in the process of opening up. With a large amount of

excellent "shots" in the hands of amateurs, already referred to, such a development would be highly desirable. One word of caution is in order here. A 16 mm. negative can not be used successfully for a 35 mm. print, whereas a 35 mm. negative yields both 16 and 35 mm. prints.

The smoothness and perfection of the professional film is due not only to careful planning and editing, but also to camera refinements permitting dissolves, fades, special effects, such as time-lapse and time-increase devices, and other aids to unbroken continuity, not available to the amateur. However, these requirements usually can be introduced later into negatives, thus greatly increasing the effectiveness of the picture.

By availing himself of such advantages and those afforded by the judicious use of animated drawings, wherever needed, the amateur cinematographer may confidently look forward to the greater and increasing field of usefulness which his product deserves.

ANIMATED DRAWINGS*

A Discussion of Their Production and the Equipment Required

J. A. NORLING

Loucks and Norling Studios, New York, N. Y.

Animated drawings provide a means of obtaining motion pictures that cannot be produced by ordinary cinematography. A description of the fundamental procedure in making animated drawings for technical motion pictures follows.

The production of animated drawings requires three things:

1. A knowledge of the elements of motion. The special qualification is the ability to analyze a movement and "break it down" into its phases or steps. Each individual phase of a movement must be appreciated before an animated drawing properly can be made.
2. An ability to make freehand drawings and a working knowledge in the use of drawing instruments.
3. Equipment for photography.

* Received for publication November 16, 1932.

ANALYSIS OF MOTION

There is little practical literature on the subject of motion analysis that will be of benefit to the aspiring animator, but for those interested in this subject reference is made to *Movement*, written by E. J. Marey of Paris, and published by D. Appleton and Company. It was published in 1897 and copies are hard to obtain outside of the leading public libraries. Many works have been published on time-study, but will be found to deal with the study of movements as applied to factory production. As reference works for the student of efficient machine and factory operation they are valuable, but are of little use in studying movements for animated drawings.

The animator will find it necessary to make an individual study of each movement he attempts to animate and learn for himself how to break it down into "units" of action. He must consider the time element as well as movement. For instance, in making animated drawings of the swing of a man's arm, he must know how long such an action will take. He proceeds to break down the time of the complete movement into parts that will be determined by the projection "speed" of motion picture film. Since the projection speed is standardized at 24[1] pictures a second it will take 24 drawings to synthesize this movement by animated drawings that will consume one second of projection time. If it is desired to increase the time more drawings must be made. Fewer drawings will, of course, make it possible to decrease the projection time of the action. It is, therefore, possible to "distort" the time element; very rapid motions can be delayed so that a simulated slow motion effect can be obtained. Very slow movements can be speeded up so that their action as a whole can be compressed into brief time intervals, such as in animating the growth of plants or the division of a cell.

Figure 1 shows a few drawings of a set of more than one hundred which were made to show in diagrammatic form the formation of a geologic fault. The drawing at the top is the first of the series; the one at the bottom the last. In this case we have compressed a geological action that would take probably thousands of years in actual time.

[1] Since sound has been added to film 24 frames a second is standard taking and projection speed. Old standard was 16 frames a second.

MAKING THE DRAWINGS

Animation demands a certain amount of artistic skill. Few artists have the ability to make a theatrical amusement cartoon, such as Mickey Mouse. It takes several years of training to acquire enough skill to produce animation of this sort. This training involves more than the specialized development of an artistic ability, as motion must be translated from a natural simulation of motion into motion in synchronism with

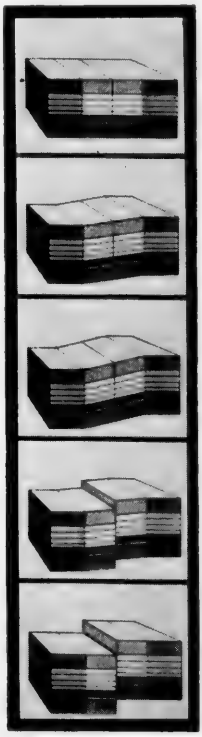

FIG. 1

musical rhythm. This requires a time and space distortion of the actual that the technical animator rarely has to consider. Anyone who has a reasonable talent for drawing can develop the ability to make satisfactory technical animation, if he studies and analyzes the movements involved. In this connection even the professional animator occasionally feels uncertain enough about the ultimate results to make test drawings.

These he photographs and projects to see how the action will look before he proceeds to work up the drawings into their final shape.

To make first-class animated subjects often requires bringing together the services of many specialists. Often it is necessary to have a retoucher work up missing or indistinct detail in a photograph if one is to be used as the background for the animation. The air-brush artist

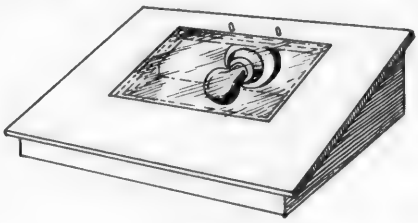

FIG. 2

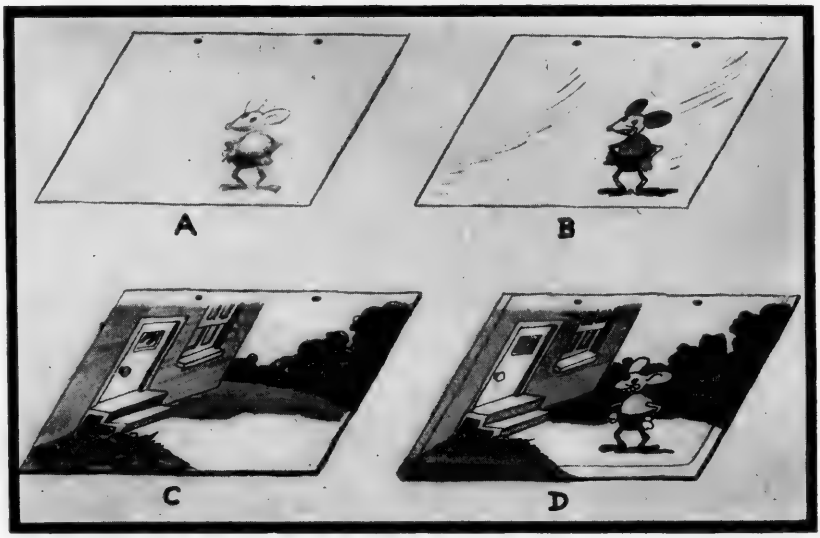

FIG. 3

may need to be called in to do air-brush shading to obtain the proper metallic gleam on machinery or instruments. For medical animation only those artists who are also good anatomists can be depended upon to produce a really satisfactory job. For technical films of any sort at least a working knowledge of the subject to be filmed is required of the animator.

Plain line animation can be made on a good quality of bond paper. India ink must be used for photographic reasons. A means of registration for each drawing must be provided. A special drawing board is required (fig. 2). Two round metal pegs at the top provide the best means of registration. The paper is punched and placed on the pegs. Several sheets can be placed on the board and each will be in accurate position in relation to the others. An opening in the board is fitted with a piece of glass. A lamp below the glass provides light so that the drawings below can be seen through the top sheet. Thus a drawing in progress can be guided by that beneath it.

Most animated drawings are made on celluloid sheets as this transparent material allows the use of a fixed background. Let us consider figure 3 in which the pencil drawing is first made on paper then traced on celluloid with India ink. The open spaces within the figure are painted in on the back of the celluloid with opaque colors of the desired shade. In *A*, we have the pencil drawing; in *B*, the celluloid tracing which has been "opaqued;" in *C*, the wash drawn background; in *D*, the celluloid on the background in position for photographing.

When all the drawings have been made and are ready for the camera an "exposure sheet" is prepared so as to relieve camera operations from all but routine functions. This division of labor, whether all steps in animation production are performed by one man or many, will assist in the prevention of camera mistakes and the resultant expense and delay due to retakes. Orderly efficiency should be the watchword at each step in the production.

PHOTOGRAPHIC EQUIPMENT

The photographic equipment required is comparatively simple. An outfit consists of a camera provided with a means of exposing one frame of film at a time which is mounted rigidly in a frame, (either metal or wood). Proper lighting equipment, a frame fitted with a glass under which the drawings are placed, are also necessary. Figure 4 shows a very satisfactory stand for animation, equipped with a spring-driven camera. This stand can be fitted with a glass frame at small expense.

A description of a more elaborate equipment may be interesting to the advanced worker. Figure 5 shows such an animation stand which is capable of handling all types of work. It is adjustable to take drawings from 3 x 4 inches up to 30 x 40 inches. The camera is motor driven

and controlled by an electromagnet actuated either by a hand switch or a foot switch. The motor drive may be reversed for photographing drawings in reverse order.

An outfit of this kind allows "zooming" down to a portion of the drawing to show a close up. Double exposures and all sorts of trick effects

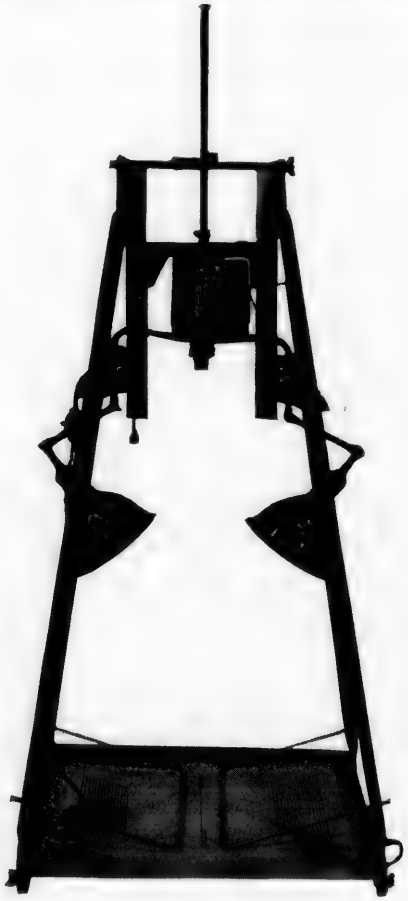

FIG. 4

are possible. The camera is equipped with four lenses of different focal lengths, so that by merely swinging the lens turret around, long shots and close ups can be made without elevating or lowering the camera. A motor driven screw is used to facilitate the raising or lowering of the camera.

For double exposure work, such as may be required in making composite animation on an actual scene, a camera of the utmost precision must be used. The camera shown here is a standard Bell and Howell professional model, which is best for such work. It is provided with registration pins and a shuttle movement which locks each frame into

FIG. 5

place for each exposure. This provision is absolutely necessary to obtain the perfect "matching" required in composite photography.

It is obvious that unless many short cuts are devised, the art of making animated drawings would be extremely tedious. Therefore the technical animator takes advantage of many processes to assist him in his task. Photography and printing come to his aid if he knows how to introduce

these media into this work. He may find that if he needs a great number of drawings, identical in all but some small detail, he can make a set of photostat reproductions and work in the animated details; thus he saves laborious repetition in drawing. The first class animator is not necessarily the one who spends a great deal of time on each drawing. But he is a person who can visualize the picture as a whole and eliminate useless detail and drudgery to achieve the desired result. Simplification should be constantly sought after. If he is so guided he will find that simple drawings will often be better in the final result than if the animation is made up of complicated detailed drawings. The quality of drawing does not depend upon elaborate and intricate detailed rendering, but upon clear, sharp and bold delineation. If the drawing is in line make heavy lines that are easily seen; if the drawings are shaded (by wash, charcoal, pencil or air-brush) make the shading in bold contrasts so that it will appear brilliant and in bold relief when projected upon the screen.

Only an attempt has been made to tell briefly how animated drawings are made and what is needed for their production. The technique is so involved in many of its phases that it would need a much longer article than this very brief résumé to go into detail. However, it is hoped that anyone seriously interested in animation will find in it something of value.

PRODUCTION OF A DARK FIELD MOTION PHOTOMICROGRAPH EXHIBITING FLAGELLA IN MOTILE BACTERIA*

R. P. LOVELAND

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The motion picture film, "Motility in Bacteria," represents material that was made in July and August of 1930 in the production of one unit of a general advanced educational film on bacteria. The more general program has been held up by the pressure of other work, but since this unit was almost complete, it seemed worth while to present it together with such description of the techique of production as may be of interest and help to workers in motion photomicrography. This film has never

* Read at the October, 1932 convention of the Biological Photographic Association.

been publicly shown in the United States, although it has been exhibited in Europe before several international conventions.

Through the courtesy of Dr. Bayne-Jones the film was made in a laboratory of the Bacteriology Department of the University of Rochester Medical School, and I wish to thank Dr. Bayne-Jones for his very material assistance.

During this work the paper by Dr. Franz Neumann of Giessen[1] was discovered. He had made dark field motion pictures of motile bacteria, and Dr. Khun, who is director of the Health Institute where the work

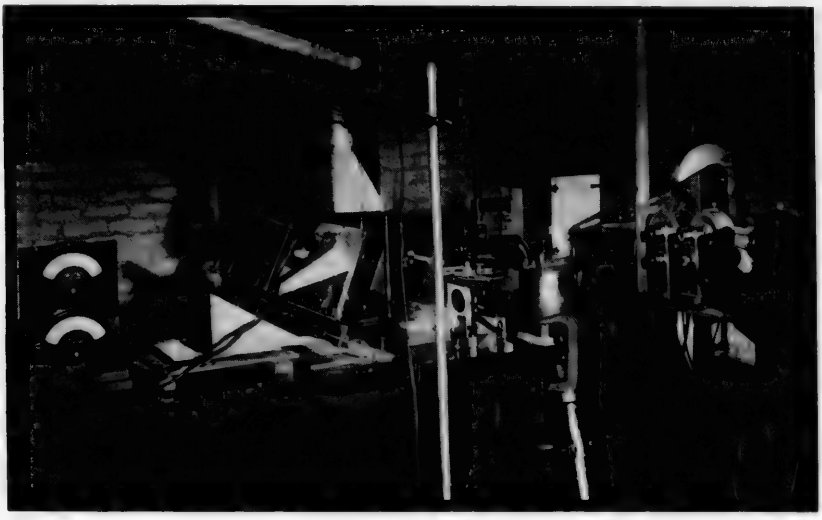

FIG. 1

was done, was kind enough to send us two types of bacteria that had been especially satisfactory for the purpose.

Since the picture was made for production rather than research purposes, it was made on 35 mm. film. A hypersensitized panchromatic film was used, because the present supersensitized panchromatic film had not yet appeared.

Because of the location of the work, the apparatus had to be semiportable and was especially designed or assembled for the work. It has

[1] *Centralblatt f. Bakter*, Abt. 1, Orig., 109, 150 (1928).

been described in detail elsewhere[2] so that only the points of special interest will be mentioned here.

The camera used for normal or high-speed motion photomicrography should run smoothly and easily, with small inertia in the moving system, and, unless it is supported on its face, should have a broad base and low gate position. The camera used for this picture did not fulfil these conditions but has since been replaced by one that does.

Stability and freedom from vibrations are among the paramount virtues of apparatus for motion photomicrography, especially when high magnification is combined with normal or high camera speeds. Certain basic requirements must be fulfilled by a satisfactory camera support. It must be independent of the microscope support, very stable, and uninfluenced by the intermittent camera motion. Moreover, it should

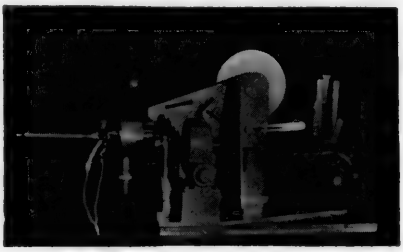

FIG. 2

permit raising or lowering the camera vertically to clear or engage in a vertical light lock (if a vertical microscope is used), and it should be possible to get the camera easily out of the way for visual work yet have it instantly ready and in alignment when wanted. This was achieved in our case by a specially designed iron tripod that carries two wide, short concentric cylinders, the inner one of which, in turn, carries the camera. It can easily be raised, lowered, turned, or clamped firmly in position. Moreover, the mass is so great that the inertia of the camera has become a negligible factor.

If a good solid vibrationless floor is available, we prefer to mount the microscope on a solid support and mount the motor drive unit on a floating system of sponge rubber or otherwise, rather than the other way around which is more usual. It is then possible to manipulate the ob-

[2] R. P. Loveland: "An Apparatus for Motion Photomicrography on 35 mm. Film." *J. Opt. Soc. Amer.*, xxii, 161 (March, 1932).

ject or move the mechanical stage during photography without danger of setting up vibrations, if the mechanical stage works smoothly. The various types and makes of microscope stands vary enormously in the degree to which a highly magnified image is affected by external vibrations.

The film was made at the normal silent camera speed of 960 frames per minute (16 frames per second) with the exception of some footage at twice normal. The camera drive unit was the one regularly used including use in time-lapse work. Since there has been some criticism of belt drive units in motion photomicrography,[3] a brief general discussion of this drive may be of interest. The outstanding feature of such a unit is, of course, economy. This drive was built for but a fraction of the cost

FIG. 3

of a satisfactory gear unit that would have the same range of camera speeds. If certain specifications such as are listed below are adhered to, belt slippage is negligible or practically constant and in our case, at least, the unit is entirely satisfactory. It drives the single turn crank of the camera by means of a rigid shaft containing two universal joints and a sliding connection, all of which reduces the transmission of vibration to the camera.

1. The diameter of the pulleys must be as large as is practicable and should have "V" grooves.
2. There should be adjustable idlers for all belts.
3. Belts must only be used for comparatively fast camera speeds.

[3] O. O. Heard: "Some Practical Considerations on Time-Lapse Motion Photomicrography." *J. Biol. Phot. Assoc.*, i, 4 (September, 1932).

Below 60 r.p.m. one or more standard commercial gear reduction units can be added by means of a simple notched clutch. Speed variations by factors of 2 are made by the choice of pulley connections.

4. A minimum of pulleys (3 sets) are used and there are never any running at one end without load. This is very important if vibrations are to be kept down. With this simple combination a continuous range of speeds separable by a factor of 2 is available; in our unit the range lies between thirty-two frames per second and one frame every four minutes. A Century Studio stand makes an ideal support for the drive because of its mass and the ease with which the height of the drive can be adjusted. While such a camera drive is not quite as convenient as a good variable gear unit, it is satisfactory.

The high magnification, dark field motion pictures taken at normal speeds required illumination of as high an intrinsic value as could be obtained. It might be noted here that for identical fields, the Supersensitive Panchromatic 16 mm. film would require about four times less exposure than the Supersensitive Panchromatic 35 mm. film, because of the difference in area. For an individual research worker the 16 mm. outfit seems to be the more practical.

In order to reduce the light exposure on the bacteria without affecting the photographic exposure, an auxiliary shutter, synchronous with that of the camera, was interposed in the light beam. A counterbalanced bristol board shutter of variable aperture was found to be the most satisfactory because of its small inertia. This shutter was operated by a flexible shaft cable $\frac{5}{16}$ inch in diameter, the combination "U" of the S. S. White Dental Company. The shaft was driven from a gear head, attached to the motor drive unit, which also drove the shaft for the camera (fig. 2). The loop of the shaft was supported by rubber sponges since it must not, on any account, touch the floor or any apparatus.

A Sperry high intensity electric arc was used supported on a tray resting on sponge rubber. Although its normal rating is 38 amperes with 45 volts across the arc, we were forced to overload it with increased voltage to 43 amperes to get the required exposures.

The optimum exposure for the bacteria, themselves, was insufficient for the flagella so that the bacterial cells had to be overexposed. Some of each type of exposure are included in the film.

Much difficulty was encountered because of the sensitivity of the bacteria to such strong light. It was necessary to cut out both ends of the spectrum, that below the blue and the infra-red heat waves. Gelatin

filters faded badly in the intense light and even all liquid filters for the ultra-violet were very fugitive. Quinine sulfate was quite useless. A 1 per cent solution of G salt was finally adopted together with a 2-inch layer of copper sulfate solution. Better definition was obtained on hypersensitized panchromatic film using an apochromatic objective when 3 per cent copper sulfate solution was used rather than a 1 per cent solution, but the latter gives appreciably more exposure. We used a 2 per cent solution.

Except during actual photography, a liquid visual filter of 50 per cent nickel sulfate and 20 per cent copper sulfate was used in a 1-inch layer. The field could be easily seen and the bacteria seemed to be unaffected by this light.

A number of optical combinations for the dark field were used but all of these pictures were taken with the Zeiss cardioid (1925) condenser and their special X 3 mm. apochromatic objective.

A split-beam viewing device is essential for such work. Ours was a modification made by Bausch and Lomb Optical Company of the viewing device on the Ciné-Kodak outfit sold by them. By making the eyelens of the device focusable on the cross hairs, *any* observer, without respect to his personal degree of accommodation, will place the aerial image to correspond with the best photographic focus, *if the apparatus is correctly calibrated*. Moreover, by increasing the power of this eyelens to make this visual focusing more critical than that on the film, the quality of the final results was improved.

Negative amplifiers are used in place of the usual positive oculars to correct the system for the sine condition and are as optically efficient as the latter. In our case these amplifiers were also the compensating type for use with apochromats.

Several types of dark field cell were used, including the Zeiss quartz chamber and the "Oelze," but for this purpose ordinary new microscope slides, carefully selected for thickness were best. When a drop containing motile bacteria was covered by cover glass, the bacteria seemed to be able to swim freely but were more restricted in the focal plane than in a cell deep enough to allow Brownian motion.

BACTERIOLOGICAL TECHNIQUE

Two specimens were received from Dr. Khun of Giessen: (1) *Vibrio elvers*, a montrichous organism said to have an unusually large polar flagella and (2) *Spirillum volutans*, which is quite a large organism.

The amount of motility in a viable culture of a motile type of bacteria seems to be dependent on the technique employed, both with regard to the per cent of motile organisms present and the vigor of the motility. Many of the immotile cells (of motile type) are perfectly viable with regard to propagation in culture. In fact, it is easily possible to go from apparently non-motile (cells) to vigorously motile ones with the same organism. Added to this controllable variation it was observed, at least with *Spirillum volutans*, that even with apparently the same technique the cells went through what seemed like periods of inactivity.

Since all motility is usually lost in a water or physiological salt solution, suspensions in peptone water were used.

FIG. 4

The motility of bacteria is very much dependent on the nature of the culture media. In fact, very little motility was obtained at first with some organisms when grown on the usual media. Glucose added to the media when possible usually increased the motility of the cells. The best motility with *Vibrio elvers* was obtained using a culture medium consisting of 0.1 per cent cystine and 1 per cent glucose added to a typical blood agar.

Plain agar was usually quite good enough for *Spirillum volutans* since glucose agar made them move too rapidly.

An interesting case is presented by *Proteus vulgaris*. As is well known, the colony formation changes markedly when the cultures on plain agar media are grown at room temperature instead of at 37°C. This corresponds to a change in motility from practically non-motile organisms grown rapidly at higher temperatures to motile cells with much longer

flagella when grown at lower temperatures. Moreover, the lower the temperature the longer is the undivided cell or chain of cells. These long chains quickly break up when their temperature is raised.

Neumann's technique for obtaining motile cells from this organism is very good, and is as follows: Inoculate a plain agar plate by merely touching the loop to the center of the plate and allow it to stand for two or three days at room temperature. At the end of this period, take the sample from the farthest edge of the growth.

A very helpful bit of technique may be mentioned here. In sampling for motile organisms, much care should be taken not to touch the wire loop of peptone water either to the solid media (or colony) or to the microscope slide. Apparently the motile organisms swim up into the loop, then down again. At any rate, the percentage of motile to non-motile cells is higher when this method is used.

Following Neumann's technique again, a 5 per cent gum arabic solution was incorporated in the 2 per cent peptone water used for the micro-cells. This slowed up the movement and tangled up the flagella until they were large enough to be seen. It was necessary to clear the gum solution by boiling it up with egg white and then filtering.

The author would be glad to furnish further information on the design of the apparatus if such information would prove helpful.

PHOTOGRAPHY IN MEDICINE, SURGERY AND THE BIOLOGIC SCIENCES*

R. PLATO SCHWARTZ,[1] M.D., AND HARRIS B. TUTTLE[2]

From the Department of Surgery, Division of Orthopedics, Rochester University School of Medicine and Surgery

A deeply sympathetic interest in the purposes of the Biological Photographic Association fostered the acceptance of your President's invitation.

The organization of this society is the expression of an intent of purpose which is worthy of approval. The wide scope of the work done by

* Read before the Biological Photographic Association, October 20, 1932.

[1] Associate Professor Orthopedic Surgery, Rochester University School of Medicine and Surgery.

[2] Eastman Kodak Company.

your members points to the difference in problems resulting from the need for photographic records of biologic phenomena.

Still-photography has a permanent place in science and medicine as indicated by the use made of it over a period of many years. The advantages gained by the records provided in these fields were long favored by the assistance of professional photographers. However, the success of such pictures depends largely upon a thorough understanding of the many problems involved and, therefore, calls for specialists in this branch of photography.

The founding of the Biological Photographic Association marked the beginning of another day. Its membership has the advantage of minds technically trained and free from the limitations of the artist. Your work must serve equally well a wide range of requirements. The sharp contrast in black and white line-drawings is essential for reproducing graphs, but the same photographic technic would fail to reveal cutaneous lesions; the characteristics of a gross specimen for the pathologist; or the contour of bones which are chalky white in color. The coöperation of a particular academic department is dependent upon your knowledge in the selection of emulsions, duration of exposure and choice of developer, as applied to both negative and print for the purpose of making the best illustrations which the lighting of a given subject may produce.

This might, when properly applied, seem to be sufficient technical skill for one person to supply for the advantage of a given institution. The content of your JOURNAL proves the contrary. The names, Creer, Heard, Stout and Borden, are associated with the application of moving pictures to the field of photomicrography, medicine and surgery. Their articles represent a background of interest and active work extending over a period of years. They call to mind certain problems relevant to the future advantages of moving pictures in these respective fields.

As a group interested in cinematography, this society may lend its constructive influence toward defining the point of view to be expressed by active efforts in various schools of medicine. At present, there are no principles of conduct generally accepted for governing the introduction of moving pictures into the curricula of our medical schools. Opinions vary as to the value of moving pictures in the teaching of medicine. Some who oppose their use present justifiable objections. The burden of proof, therefore, rests with those who will support their positive convictions by the time, effort and money required to produce films of quality for teaching students of medicine.

Having thus defined the principal source from which we may expect an answer to this question, consideration might be given to the choice of method most suitable for the purpose.

Certain standards of quality peculiar to moving pictures have been established by familiarity with films produced for entertainment. Methods of production have included expensive equipment. This has been justified by a demand which more than equaled the cost of films in the field of amusement. One or more efforts have been made to produce surgical moving pictures on a similar basis. The cost was much greater than the demand for the films produced, although the quality of production was unquestioned. The demand was small for the following reasons: (1) it is not generally accepted that moving pictures are as essential to the teaching of surgery as is the use of the microscope; (2) where sympathetic feeling might favor the use of such films, objection was raised as to agreement with the subject selected, the method of presentation, and the surgical technique which was used; (3) there are several factors which discourage absolute standardization of surgical technique such as is fostered by moving pictures of operative procedures; (4) it is claimed by some that moving pictures of operations frequently make complicated procedures seem simple, thus encouraging those who are poorly trained to take unjustifiable risks with patients.

These four reasons account for the failure of those efforts directed toward the development of surgical motion pictures on a production basis although the experiments were adequately provided with money and conducted by the best trained minds.

Such failure does not imply that no further efforts should be made to provide films suitable for use in the teaching of surgery. We are, however, forced to give serious consideration to the lessons taught by these past experiences. Your efforts should be directed toward the solution of problems confronting the individual surgeon interested in cinematography as related to the teaching of surgery. Considerable work of excellent quality is now being done at the personal expense of men in surgery, medicine and dentistry. The interests to be served require that we should know of their work which reveals the fact that personal interest and resourcefulness with little equipment may produce excellent films. These individual efforts deserve recognition and encouragement. Such may be provided by giving assistance to those who reside in your respective cities. Their interests should also be served by the creation of a central group to be mentioned later.

The value of moving pictures in the teaching of surgery should, in the future, be largely determined by the efforts made in the respective medical schools and teaching hospitals. It will depend most upon the selection of only those subjects which readily lend themselves to visualization by this method of photography. The quality of work must approach that which the field of entertainment has taught us to accept as good.

Such efforts in separate institutions deserve stimulation. This can be provided by the mutual adoption of measures which will most favor the production of the best films at the least cost. In this connection two considerations may be presented: (1) Coöperation in the standardization of methods and equipment most suitable for photographing a particular subject under given conditions; (2) the exchange of films produced by various schools and individuals.

These important points warrant further explanation. Both advantages could be best served by a central body. The problems pertaining to the technique of moving picture photography could be presented to this group. Helpful consideration from such a source would lead to the elimination of costly mistakes and improvement in the quality of films not classed as complete failures. This same group might also serve as a clearing house for the exchange of films. To fulfil this purpose, a list of films produced would be indexed. From this department one could learn where to locate a film illustrating a particular subject. Besides saving the cost of making so many films in each school, students might be given the advantage of seeing methods as applied in other schools.

Although these two suggestions have been made in connection with the discussion of surgical motion pictures, the advantages to be gained may be common to all subjects so illustrated.

Opinions from abroad register strong conviction in favor of advantages provided by the use of motion pictures in the teaching of medicine. Professor A. W. Fischer (1) and the psychiatrist, Dr. E. Herz (2), writing in the *Deutsche Medizinische Wochenschrift* state that cinematography should be used for medical instruction much more than it has been. In discussing the subject, Fischer demands "more particularly the practical development of film for the imparting of instruction in surgery," while Herz demands "a systematic collection of films dealing with the subjects of research on movements in general in man. Only a central institute could accomplish these tasks. The Kaiserin-Friedrich-Haus in Berlin, which promotes post-graduate medical education, has already

begun to prepare a catalogue of all existing medical films, but that is only the beginning. How the film should be used for diagnostic purposes in nervous and mental diseases is shown by Herz in his application of the method to the study of motion; for it will be recalled that it has become possible by means of films to distinguish pathologic from normal movements. Numerous other problems have been elaborated in the same manner. The restless movements of certain mental patients were studied in their peculiar form by means of a careful analysis of the films. The film may be used also as an aid in establishing the degree of disability, since the manifestations of attacks are given a fixed form in the film and serve them later as undeniable fact-finding material in rendering a decision in a given case. Thus the film takes on the character of evidence in various procedures. But the film has possibly its greatest value in the presentation of manifestations of mental patients in classroom instruction. A knowledge of the disturbances of motion cannot be properly imparted without a 'film textbook'."

It may not be possible to provide these or similar advantages in the near future for the benefit of moving pictures in medicine, surgery and the biologic sciences. In the interval, each individual must use his own interest, initiative, ability and equipment for solving his own problems to the best advantage.

Relatively rapid developments have marked the introduction of 16 mm. moving picture film. This was first announced by the Eastman Kodak Company, along with the Ciné-Kodak and Projector, in 1923. Improvements in film emulsion have led to diminishing requirements for special lighting equipment. In 1931 supersensitive panchromatic film was made available by the Eastman Kodak Company and complete data is given in the *New York State Journal of Medicine*, October 1, 1932 (3), for the use of this film in surgery. It is now possible to photograph operative procedures with the lighting equipment present in any modern operating room. The making of medical motion pictures in color requires but little additional illumination. Stout (4) has described his method of making Kodacolor moving pictures of an operation. He states that "satisfactory black and white pictures may be taken at F 4.5 by the illumination of the ordinary operating light, but for Kodacolor pictures a considerable amount of auxiliary illumination is necessary. Eight small automobile spotlights were fitted with double filament 32–32 candle power 8 volt bulbs, all of which were connected in series and at-

tached to the operating light." He has well described the other essential details of his electrically controlled camera. The number of moving pictures which have been made in various operating rooms reveals that it is possible to avoid breaks in technique from this source. With the small compact 16 mm. camera, inexpensive 16 mm. supersensitive panchromatic film, modern lighting equipment and long-focus lens, excellent moving pictures can be made for record, teaching and study. This makes us chiefly concerned with the completion of a program which will lend assistance to hospitals, schools and those unrelated to teaching centers, so that all may improve the quality of their work.

Most, if not all, teaching films require some animation to fully reveal their meaning. This is particularly true for those to be used for undergraduate teaching. Some believe that it applies equally well to those used for graduate instruction. We have constructed a 16 mm. animation camera, using a Model A Ciné-Kodak which was rebuilt to meet the requirements.

As the result of much effort and considerable expense, sound is now applied to cinematography. There is at least a limited field wherein it may become very useful in the respective subjects of medicine, surgery and biology. "Professor Gosset recently presented a sound film before the Academy of Medicine (in Paris). It was prepared under his direction, by Mr. J. Benoit-Levy, which opens a new path for the educational film. This film is designed to show the various stages of a surgical operation (an appendectomy), and Mr. Gosset, for greater clarity, used the motion picture. In the first part of the film, a succession of pictures shows the various stages of the operation, while the voice of the professor is heard describing them in a clear and precise manner. In the second part is presented the real operation, the various stages of which are exactly superimposable on the motion pictures previously projected. Mr. Gosset after his presentation, explained that it had been his desire to produce a film suitable for instruction, pointing out the great interest that surgical science has in recording its various forms of technic in a permanent manner. He looked over recently, through the courtesy of the son of Dr. Doyen, the films that were taken long ago of diverse operations performed by the latter, which enabled Gosset to take account, after many years, of what was good and bad. One can judge thus of the improvement in the technic and of the progress that science has made. Such films have, therefore, considerable interest for preservation in the archives of the history of surgery. The audience had one criticism to offer on Mr.

Gosset's film. The presentation was a little too rapid to permit them to follow all the details of the operation " (5). The usefulness of sound must depend upon the advantages which silent pictures may reveal.

The Biological Photographic Association may be most helpful in fostering the application of educational films to the subjects already mentioned. Any effort in this direction will be made more effective through the creation of a department for the purpose of giving advice and instruction in cinematography as applied to this form of illustration. Information relative to the location of films on various subjects should be provided by this department. The interest revealed by individuals unrelated to teaching institutions should be supported by such a department. By giving them your personal assistance you would do much toward stimulating further growth in the application of cinematography to the teaching of medicine, surgery, and biology.

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NATIONAL CONVENTION OF THE AMERICAN SOCIETY OF RADIOGRAPHERS

The national convention of The American Society of Radiographers will be held at Rochester, New York, from May 31 to June 3, 1933. The program for this convention will not only be most interesting but very instructive as many outstanding authorities will speak on subjects of major importance to the radiographer.

Members of the Biological Photographic Association and others interested in this work are cordially invited to attend. Further information may be obtained from Mrs. Hazel Englebrecht, 302 Equitable Building, Des Moines, Iowa, who is chairman of the Program and Entertainment Committee.

PRINTS FOR REPRODUCTION AND THEIR ARRANGEMENT FOR PUBLICATION

LOUIS SCHMIDT

From the Illustration Division, The Rockefeller Institute for Medical Research, New York

It has long been the custom for photo-engravers to demand glossy prints, not because they are glossy but because they are smooth in the highest degree.

Recently a photo-engraver declared at a meeting that semi-matte prints would be just as acceptable, since they are equally as smooth and when in a copying frame under glass photograph exactly the same as the glossy prints. Many photo-engravers are strongly in favor of the use of originals large enough to be reduced in making reproductions. In my opinion, this is a device suggested in the first place by the artist, making the work more free and enabling him to put fine detail into his drawing more easily. There is no reason why our originals should not be reduced; neither is there any considerable advantage.

In the case of photo-micrographs, it is rather impractical because a photograph magnified 500 times and then reduced one-half is not the same as one at 250 and reproduced at the same size. The difference would be more marked if the photograph were made at 2,000 and reduced to 1,000 by the photo-engraver. To make enlargements from the negatives and then have the photo-engraver reduce these back to the original size would add to the expense, with very little or no improvement in the final result.

Again, if the print is submitted to the author on a scale larger than the final printed result, there is likely to be confusion when the proof is returned by the engraver.

If prints are submitted to a journal where the editor decides on selection, grouping and arrangement, it is best to send the prints unmounted and packed in such a way that they will not be cracked or scratched. When a number of prints are to illustrate the same paper, it is advisable to have them as nearly as possible of uniform quality and color. This is sometimes difficult or impossible, but it should be our ideal.

If it is puzzling to determine the top of the picture as in photomicrographs, it should be marked on the *back* of the print. It is also well to indicate the minimum area which should appear in the illustration if the

entire area is not required. This should be lightly marked on the back with a soft lead pencil. If the print is placed against a window, face of print against the glass, this may be easily and accurately done. These marks may also be made on the face of the print with a red or black grease pencil which may afterward be rubbed off.

For mounting we use heavy cardboard that will not curl and Asco frisket cement, made by Artists Supply Company, 7610 Decker Avenue, N. E., Cleveland, Ohio. This adhesive costs more than paste but has many advantages. Where a considerable number of small bits are used to make up a page, some ingenuity is required to make the page presentable and include all the needed material. In planning a page or series of pages, we first place on a mount a piece of cardboard the size of the printed page and then make a pencilled line around it to indicate the space within which the prints must be assembled. The next thing to consider is the number of prints that must go on the page, their size and shape, and perhaps their direction. Cut-outs of one-half, one-third, one-fourth, one-sixth, and one-eighth of a page are prepared. By moving them about on the print we then determine the best way to fit it into the page, sometimes combining half pages with quarters or eighths, or thirds with sixths. Where the page is more complicated, we resort to tracing paper to make a rough layout. Sometimes it is necessary to make several before all of the figures can be combined in the limited number of pages allowed.

We found several years ago that a page consisting of a number of mounted photographs and preserving a white margin $\frac{1}{8}$ to $\frac{1}{4}$ inch wide between the figures was classed by the engraver as a vignetted page and priced at a rate 33 per cent higher than if the entire page contained but one picture. For this reason, we thereafter assembled our pages with the figures mounted edge to edge, in this way getting the same price as if the page contained but one picture, plus a nominal charge for cutting a dividing line between the figures.

If there are arrows, lines or letters to be placed on the prints, it is best to cover the assembled page with tracing paper and have the author or editor indicate the arrows, letters, etc., on it either with *soft* pencil or ink, at the same time making certain that the tracing paper is fastened securely to the print. The artist in the editor's office or in the photo-engraver's shop then makes the lines, arrows and other references on the page at the places indicated on the tracing paper. In doing this, it should be so arranged that the letters or figures are of suitable size in the

finished plate, depending on the reduction, if any. This information should be passed on to the author, if he and not the photographer is to prepare the copy.

The matter of screen to be used in making the half-tones is of great importance, since the paper is a part of the picture. Where a fine grade of paper is employed, we rarely use a finer screen than 175 lines per inch, and if the illustration is to go into the text, 150 is fine enough.

THE ART OF PHOTO-RETOUCHING

JAMES R. HOWARD, JR.

Baltimore, Maryland

The field of photo-retouching is understood by a limited few; those who have studied at art schools as well as those that have been trained entirely in the shops and art departments of engraving houses and commercial art studios. It might well be termed the unwritten field as little material of worthwhile value has been published on the subject.

It is not my purpose to go into details but I trust this article will give those who have the desire to work a footing from which to expand their knowledge and experience; also information to those who are interested from the standpoint of having an artist do the work for them. I trust it will open up new avenues into the realms of photo-retouching stimulating their imagination and indicating possibilities that hitherto had not been conceived.

The traditional camera that never lies is so thoroughly infested with untruths that probably we shall never account for all. It is the photo-retoucher that has to answer and rectify the failures of the camera. His lot is not an easy one.

Photo-retouching is about the most uninteresting branch of commercial art, including lettering. The requirements for even moderate success in the field is a better knowledge of light and shade and imagination for the forcing of light and shade than is needed in any other branch of art. The retoucher must understand composition and the rudiments of emphasis and subordination to accomplish his purpose. This together with a certain mechanical turn of mind and a gift for patience probably completes the array of essentials vital to the photo-retoucher.

My purpose here is to give a brief survey of the possibilities of photo-retouching, just what can be expected, also sufficient instructions in regards to materials and execution to help the person that possesses some art ability to retouch his own photographs. The numerous uses for photo-retouching in our present economic system is invaluable. Likewise, photography could not have the same value to the scientific world without photo-retouching.

Supporting a previous statement, the photo-retoucher injects that which the mechanical camera failed to correctly portray. He has the possibilities of introducing in a photographic manner, supplements, cross sectional views and additions or subtractions as desired. Blemishes on machinery can be obliterated. When it is necessary blemishes of a skin disease on a medical photograph can be enhanced to insure perfect representation in reproduction. However, when this is done no effort should be made to exaggerate or diminish the condition. Certain portions and parts can be subdued so that certain other portions and parts may enjoy the necessary attraction. Unnecessary objects may be toned down or eliminated and given their proper place in the scale of values and composition. It is here that composition in line and tone and profound training in aesthetic feeling lifts the work of the artist above that of the mediocre technical retoucher. Photo-retouching is the process of elimination and emphasizing and subordination as the requirements may dictate.

Photo-retouching is divided into two classes, detailed and pictorial. Pictorial carries us into the fields of portrait and landscape and therefore will not be dealt with in this treatise. Detailed takes us into the technical and scientific realms.

A photograph may be outlined, which means eliminating the background entirely and allowing the selected object to stand alone on the white paper. Vignetting means to gradually shade or grade off into a blended cloud effect and thereby gradually to disappear into the paper. Vignetting is quite an old method of handling the proposition and is also an expensive one. Engravers charge extra for making the plates and the printers charge extra for the printing of vignettes. They are rarely successful when printed as usually there forms a hard line around the blended effect which detracts from the featured object. A square finished photograph is one that has straight right-angle boundaries. There are combinations of these, as square outline, square vignette, outline vignette, etc. With well planned outlines and vignettes visualized and

executed with taste, skill, with a subduing and emphasizing of certain portions the most commonplace photograph can be made into a very successful, dynamic picture for reproduction purposes. It might be stated here that if the retouched photographs are not wanted for reproduction they can be rephotographed and the retouching becomes a part of the photograph.

Unretouched photographs of machinery seldom show intricate detail. A photograph of an automobile will reflect the heavens above and the earth beneath and anything else that is in close range. Likewise with other things that have a polished surface. All this distorts and injures the shape, modeling and detail. Such subjects usually have to be retouched in their entirety. Such photographs are quite often made in poorly lighted factories and workshops where dirt and blemishes are caught by the camera. This must all be corrected by the retoucher and the subject portrayed to its best advantage. Quite often an inventor wishes to make a change on a machine, or, have an attachment portrayed before the change or attachment is actually completed. The retoucher can add the attachment or make the change on a photograph of the machine. Quite often retouchers are confronted with the problem of making a photographic illustration of a machine before the machine is actually built. This is made from the inventor's blue prints or plans and can hardly come under the category of photo-retouching, however, the illustration should be photographic in its appearance.

Several years back prints were mounted by soaking in a tray of water. After this the paste was coated on the back and the print applied to the mount. They were then placed under a weight and left to dry. This unsatisfactory procedure gave way to the more modern method of dry mounting with heat and prepared tissue or of mounting with liquid rubber cement. This cement can be purchased at any art material supply house in quarts, gallons, or small pint containers. Figure 1 illustrates the latter method now in popular use. Part A shows a container of cement, part B a long palette knife, part C represents the print to be mounted and part D is the mount. Place the print C on the mount D, run a pencil lightly around the print then remove and apply the cement with the palette knife to the area inside of the pencil lines as illustrated by part E. Now apply cement to the back of the print. When this has almost dried apply the print to the portion of the mount to which you have applied the first cement,

smoothing down with a straight-edge using plenty of pressure. In this way you vulcanize the print to the mount. It is imperative that you apply the cement to both the print and the mount as applying to only one will not be satisfactory.

Prints are retouched with opaque water paint composed of lamp black, Chinese white and brown ochre. You can mix this yourself or procure it already mixed. The ready-mixed comes in different shades, white, three or four shades of gray and black. The ready-mixed has brown ochre added as this is necessary to match the brownish tone of the photographs and overcome the bluish cast that results from the mixture of the white and black paints alone.

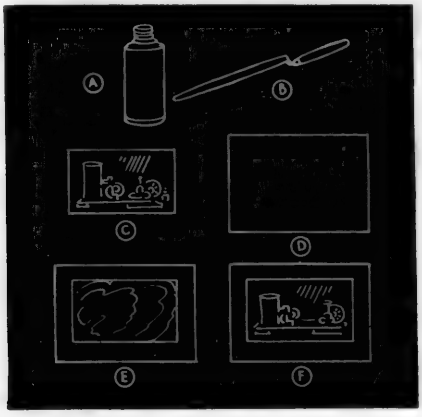


FIG. 1

If the paint runs or creeps when applied to the photograph, grease is present, and can be removed with a piece of artgum, or a little saliva on a piece of absorbent cotton.

The requirements now are to match the tone exactly wherever you apply paint. Do not forget to add additional brown ochre in your mixture when necessary. If you do not use this you may approximate the values but all your grays will photograph lighter when reproduced. Try to keep as much of the original print as possible and do as much thinking as work.

Now a word in regard to the material and equipment required. The air brush is an indispensible part of the retouching equipment. It is also the most expensive. In figure 2, part 1, is illustrated one of the

reliable air brushes. You should practise with the air brush before attempting any practical work. Any of the artist's supply houses will demonstrate for your benefit how an air brush is used. Holding the brush as you would a tooth brush you control your spray with the thumb by placing on the throttle marked *A*. The paint mixed with enough water to make it flow easily is placed in the cup marked *B* and when the throttle is manuevered with the thumb is blown through the nozzle

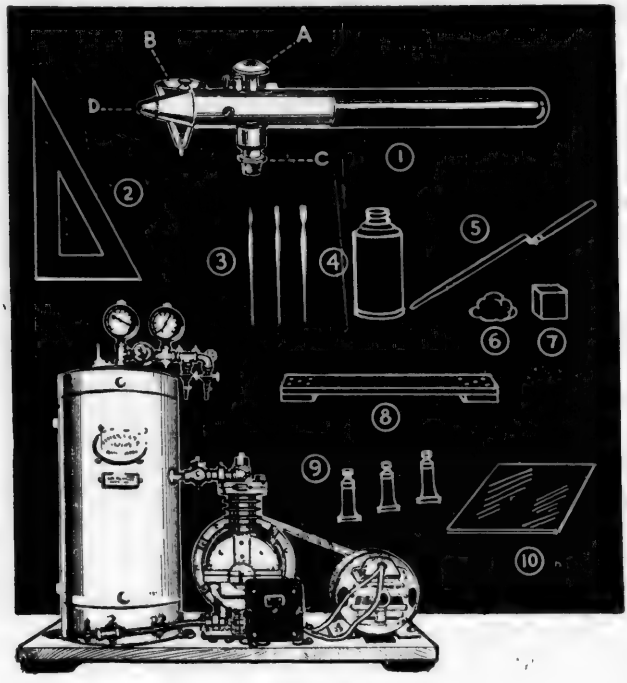


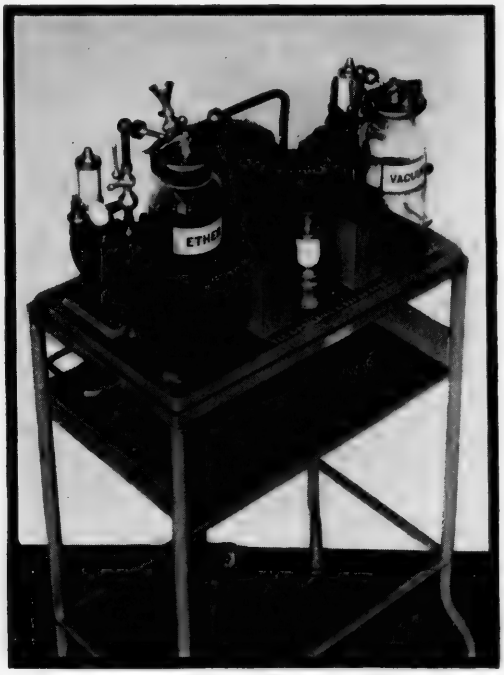
FIG. 2

marked *D* in a fine spray. The air pressure enters the brush through the connecting nipple marked *C* which is connected with the air tank by a hose shown at the bottom of figure 2. The compressed air tank shown is filled by the electric motor and pump which is attached. The motor operates automatically, starting when the pressure is reduced to 35 pounds and stopping when the pressure reaches 45 pounds. The cost of the pump, motor, tank and a good air brush is about one hundred and twenty dollars. Other equipment illustrated in figure 2 is part 2, show-

ing a 30 x 60 degree triangle; part 3 shows one fine pointed no. 2 red sable brush and a $\frac{1}{8}$ and a $\frac{1}{4}$ inch red sable chisel or flat point-brush; part 4, a can of liquid rubber cement; part 5, a long palette knife; part 6, absorbent cotton; part 7, artgum. Part 8 shows a bridge made from a piece of board 18 inches long, 3 inches wide and $\frac{1}{4}$ inch thick. At the ends are nailed cleats of the same thickness to keep the suspended part from touching the paper. This bridge is used as a hand rest while working on the photograph. Part 9 illustrates the three tubes, one each of lamp black, Chinese white and brown ochre. Part 10 shows a piece of glass 8 inches square, on the back of which a piece of paper of light color has been fastened. This glass is used as a palette to mix paint on. It is presumed that those who have a desire to retouch their own photographs have some drawing equipment, such as a drawing board, a circle pen, a ruling pen, etc., and know how to use them. The air brush is the only possible way by which a photograph can be retouched and made to retain a resemblance to the photograph. The detail is applied by hand. Long straight lines are made by placing the paint in the ruling pen and running it out along the edge of the triangle where desired.

We shall now take the untouched photograph (fig. 3). The necessary requirements here are to give it commercial value and certain technical points are to be pointed out or illustrated in a graphic manner. The print was first cropped to give it the close-up view as shown in figure 4. A close-up view has a tendency to bring the observer into the picture and gives us a chance to point out the technical advantages as shown in figure 4. This cropped print was mounted the same as the one in figure 1. However, here we used a piece of mounting board large enough to accommodate the added portions at the top and bottom of the print. There was considerable air brush work to be done on the stand and switch boxes to give them their proper values and contrasts. When paint is applied with an air brush it does not always go where it is desired without some of it being blown on the other parts. Therefore it is necessary to cut a mask for the various parts that need treatment with the air brush. In figure 5 is illustrated how a mask is made and used. Part A of figure 5 shows a print mounted ready to be retouched. Part B shows a piece of tracing paper applied to the face of the print with rubber cement. Here we are going to brush out the background or to speak in technical terms "outline the photograph." Therefore we proceed with a small sharp knife to cut neatly around our object and then likewise to cut

straight along the border of our print, running the blade of our knife along the edge of the triangle. We then remove the superfluous tracing paper from between the object and the border of our print. Then remove the rubber cement from the print which rubs off very easily. We now have the object protected with the mask and likewise the white margin of the mount around the print. Place white paint in our air brush and proceed to eliminate the background. After this we remove the

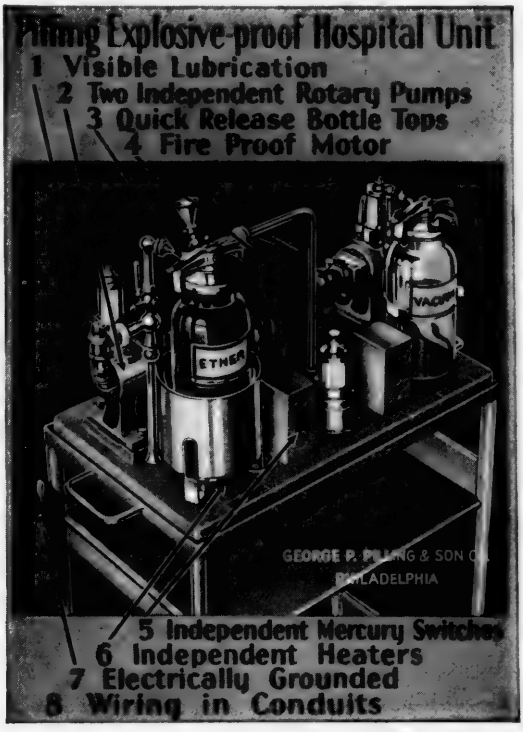


Courtesy of George P. Pilling & Son Co.

FIG. 3

mask and there we have the object outlined on a white background. This same procedure is followed when using the air brush on other portions of the picture for blending or any other air brush work. The untouched photograph (fig. 3) required a solid black background when retouched and was handled in the same manner. There was considerable blending on the stand (fig. 3) which was executed with the air brush. This is the only way that it could have been blended on a photograph and retain the photographic quality. The tube, if you will check first on

figure 3 and then on figure 4, connected to the ether jar was straightened. This was done by running the paint through a ruling pen as described before. Different values of the grays were used to give it the required roundness. The highlights and details were added with the brushes by hand. Of course this was done after the larger masses had been put in with the air brush. Please study faithfully the transformation of



Courtesy of George P. Pilling & Son Co.

FIG. 4

figure 3 into figure 4. Notice how the reflections in the ether jar have been removed and highlights added to take their place. Notice how the container in which the ether jar sits has been simplified and rounded, how some portions have been subordinated and others emphasized. There is a contrast between the untouched and the retouched photographs. However, the printed result is still photographic in appearance. The lettering (fig. 4) was the last part to be applied and was done over

a gray background. The numerals and arrows proceeding from the lettering call attention to the various technical points. This is but one of the many possibilities of photo-retouching.

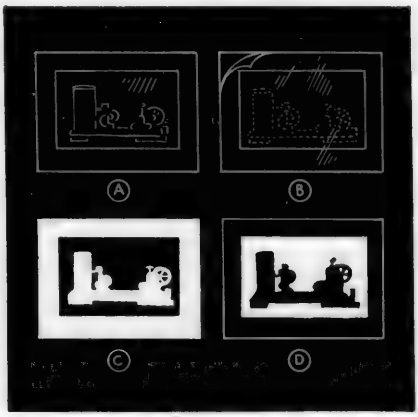


FIG. 5

A consolation to those who wish to undertake the retouching of photographs is that after paint has been applied and does not appear as it should, it can always be removed with a piece of absorbent cotton and water which will return the print to its former state ready to be retouched again.

THE FILING OF LANTERN SLIDES*

STELLA ZIMMER

From the Department of Photography, College of Medicine, Syracuse University

In my article in the September number of THE JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION I reviewed replies to my questionnaire relative to the filing of negatives and prints. There remains the matter of indexing and filing lantern slides. As might be expected, I find that the almost universal custom is to issue these positives for projection as one would extra prints, to be used in a variety of ways to which

* Received for publication December 1, 1932.

this type of material is adapted; namely, for lectures, demonstrations, class room work in schools, illustrative talks, papers, etc. In hospitals and schools, the prevailing custom is to have the various departments index and file their own lantern slides in accordance with their particular needs and uses to which they are to be put. The oustanding exceptions are at the Babies Hospital in New York and the Minneapolis General Hospital.

Mr. Robert Morrison, of the Medical Division of the Eastman Kodak Company, writes in his article on the Photographic Department of the Minneapolis General Hospital, in *Radiography and Clinical Photography*, Vol. VII, No. 3, June, 1931, as follows:

> When lantern slides are used extensively for teaching it is desirable that they be filed in an accessible manner, both as independent slides and in selective groups, so this hospital has developed a system of designation by letters which is quite effective:
>
> A—Skin
> B—Obstetrics, Gynecology
> C—Pediatrics
> D—Medicine
> E—Surgery, Orthopedics
> F—Genito-urinary
> G—Dentistry
> H—Laboratory, Gross Specimens
> K—Heart
> L—Radiographic Reproductions
> M—Ear, Eye, Nose, Throat
>
> (The letters I and J are omitted to avoid confusion)
>
> When a request for a lantern slide is presented, it is entered in a journal under the proper lettered section. The filing number is obtained from a sequence of numbers maintained for each division. If the slide has a related clinical picture, this lantern slide number is added to the three file cards of that case.

Miss MacMullen says that at the Babies Hospital, New York, certain lantern slides which are used repeatedly in lectures to the students, are numbered consecutively and filed in one group.

At the Rockefeller Institute for Medical Research; The School of Medicine, Yale University; Peter Bent Brigham Hospital and other institutions where considerable photographic work is done, the lantern slides are filed by the different departments. In all instances the negatives are on file, under some system, in the various Photographic Departments as I have described in my first article, and all departments that file their own slides should have the negative file number. Lantern slides in use

are frequently broken, scratched or otherwise deteriorated, but, if the negative file number is preserved by the department interested, duplicates can be readily and easily furnished them.

Some departments also file their prints, using the prints as an index, from which a selection of slides can be made with facility and on short notice without going over the more bulky slides. This is a particularly useful method when lantern slides are filed away in closed cabinets.

The Department of Clinical Pathology at the College of Medicine, Syracuse University, receives from our Photographic Department a print with each lantern slide. The filing system they use for print and slide, each in a way being an index for each other, and a card index governing both, seems to me to be of particular interest. It governs to date some five hundred slides, with a duplicate print, almost entirely of human blood and human blood disease. Since this system seems to work out satisfactorily, both as a matter of analysis of filing material and readiness of access with relative simplicity, I will give it to you in full.

On receipt from the Photographic Department, the lantern slide and its corresponding print, each of which already bears the photographer's file number for the original negative, is given a serial number for the file. The lantern slide is then filed serially.

On the back of the corresponding print is written general information relative to scource of specimen and the general classification (usually a diagnosis). The print is then filed in the print file, which is a series of envelopes captioned in accordance with a general classification based on diagnosis, such as pernicious anemia, leukemia, myeloid, etc. These envelopes are filed alphabetically.

An index card is given the same serial number as print and slide and carries a transcript of the general classification and other data on the back of the print. This card goes into the general serial index for the serially filed slides and for the classified prints.

A cross index file is also kept and these cross index cards are of two types filed together alphabetically. Under type I are general classification cards, with such headings as pernicious anemia, leukemia, myeloid, etc. These are identical with the captions for the envelopes of the print file, and receive the file numbers of the slides and prints which properly belong to each of them. Type 2 cards make a "special feature" classification and carry the serial numbers of the slides and prints in which each special feature may be found; for example, megalo-

blasts may be found in certain pernicious anemia slides and also in some leukemia slides, etc., lymphocytes in whooping cough, mononucleosis, etc.

In looking for illustrative material one can select and list from the index cards the desired prints to be found in their respective envelopes in the print file; or the prints may be examined in their file envelopes. The descriptions on the back are noted, also selection and arrangement. The prints, which one will recall bear the same serial numbers as their corresponding slides are used as a listing of slides for withdrawal. Prints can be temporarily arranged for some special feature and later put back in their proper general disease groups using either the general index cards or the notations on the backs of the prints. Highly technical selections and arrangements can be made easily. Listing, file cards, or selected and arranged prints may be with reasonable safety turned over to non-technical assistants who should be able to withdraw and arrange material for use, and later return everything to its proper place, without further instruction.

Courtesy of Multiplex Display Fixture Co., 910-920 N. 10th St., St. Louis

FIG. 1. MULTIPLEX LANTERN SLIDE CABINET

When slides are filed without any accompanying print and when no prints are made it is a decided convenience to use some filing cabinet, such as the Multiplex Lantern Slide Cabinet (fig. 1). that will display the slides. This has a particular advantage in that one sees the actual slide and can form an idea as to how it will project. It is the method of choice for colored slides, copy work, written lecture material and things of like nature. The cabinet keeps the slides conveniently filed at all times and protected from theft and unauthorized inspection as well as fire. Such cabinets may be obtained from Multiplix Display Fixture Co., 910–920 N. 10th St., St. Louis, Mo.

My conclusion is that regardless of in what department or in what manner the lantern slides are filed, (1) they should each have a number which refers back to the original negative; (2) they should be indexed by a card system; (3) they should be readily accessible or a duplicate print or slide available for inspection.

METHOD OF MAKING NEGATIVE X-RAY PRINTS FOR REPRODUCTION*

F. R. HARDING

From the Photographic Department, Children's Hospital, Boston, Massachusetts

The early method of making x-ray prints for reproduction consisted of making a contact print direct from the x-ray film. This gave a positive image on the paper, necessitating a mental reversal on the part of the reader. A number of attempts have been made in the direction of negative x-ray prints. Many of these have failed, due to the extreme contrast of the positive produced through the camera. There was great loss of fine detail in the finished print, especially in the more dense areas of the x-ray.

The following method of making negative x-ray reductions has been in use at the Children's Hospital for three years and has given great satisfaction to members of the staff.

The apparatus used is simple. It consists of a skeleton top stand, waist high, 6 feet long, and 13 inches wide. On this are placed two

* Received for publication October 10. 1932.

movable platforms 13 inches wide, and 10 inches long. These platforms have a $\frac{1}{2}$-inch square guide fastened on the under part, at each side. This allows them to be moved back and forth, without getting out of square in relation to each other. One platform is placed at each end of the stand. The one at the left has a tripod screw inserted. The right hand platform has a suitably braced, square "U" shaped frame fastened to it. This frame has a $\frac{1}{4}$-inch square groove cut in each upright. It is to accommodate the glass "sandwich," which is a sheet of plain, and a sheet of opal glass, 14 by 17 inches in size. In use, the opal glass side is placed toward the light. These sheets of glass are hinged together at the

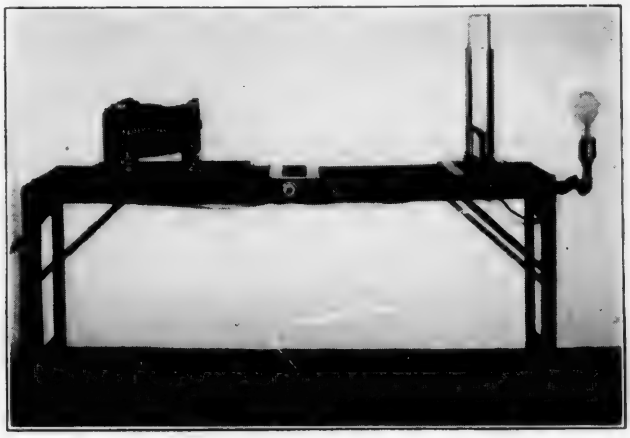


FIG. 1. APPARATUS WITHOUT THE LIGHT CONE IN PLACE AND WITH THE GLASS PARTLY RAISED

top with adhesive tape. Fixed to the right hand end of the skeleton frame, is an electric light fixture, containing a 500-watt bulb. A light cone encloses this bulb, both to intensify the light and to prevent stray reflections. This cone may be of any type, as long as it gives even illumination over the glass, and prevents stray light.

A set of black paper masks are used. We have a mask for every size x-ray from 5 x 7 inches up. These are used to block out the surplus space, when using x-ray films smaller than the whole glass.

The camera used is an ordinary 5″ x 7″ view camera, with an $8\frac{1}{4}$-inch lens. With a shorter focal length lens, the stand can be made shorter.

We have this apparatus installed in the processing room. This effects a great saving in steps, as it is often desirable to develop the first of a series of films, as a check on the quality.

To use the apparatus, the camera is placed on the platform, and made fast by the tripod screw. Then the glass "sandwich" is removed from its holder, opened, and the proper size mat is laid on the opal glass. The x-ray is laid on top of this, and the top, or clear glass, is lowered over it.

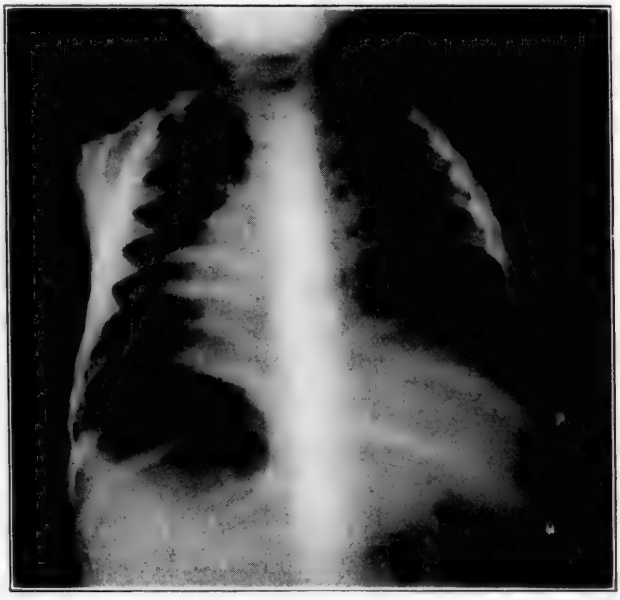


FIG. 2. EXAMPLE OF A NEGATIVE REPRODUCTION. AN ADVANCED CASE OF MILIARY TUBERCULOSIS

The "sandwich" is then lowered in the grooved uprights of the platform, and the light turned on. During the focusing and exposure, all other lights in the room should be turned off to avoid reflections on the glass. The exposure is made on Eastman Super Speed Portrait Film. The use of this film has been arrived at, after considerable experimenting. For average work, from good radiographs, no other film we have tried has given all the detail in the original x-ray. We have at times used Eastman Commercial, and even Eastman Process film, on particularly flat x-rays, which required building up of contrast for reproduction. We

stop the lens to F: 16, and give an exposure that varies with the x-ray density, from two to ten seconds.

Print the resulting film in the usual way. Most of our films print nicely on either Azo No. 1 or No. 2. grade F.

Lantern slides made from these films retain all the detail of the original x-ray, and are an excellent method of showing x-rays to a large group.

It is quite practical to use this apparatus for making movies of x-ray films. All that is necessary, is to replace the 500-watt bulb with a 1000-watt bulb. Fasten the movie camera to the platform with the tripod screw. It is usually necessary to raise the whole platform, until the movie camera lens and the x-ray film are in line. We have made many movies of x-rays, and have had extremely good results. The diaphragm opening has varied from F: 1.4 to F: 4.

Attempts have been made to use a regular x-ray illuminator instead of the described apparatus, merely setting the camera before the illuminator. The drawback is the comparatively weak illumination from the box, and the difficulty of squaring up the camera with illuminator. This method is not recommended for serious work. It is impossible to get even illumination in the illuminator by increasing the candle power of the bulbs used.

A COMBINATION COPIER AND TRANSPARENCY MAKER WITH THE MANY OTHER USES IT HAS IN CLINICAL PHOTOGRAPHY*

WILLIAM F. PAYNE

From the State Institute for the Study of Malignant Diseases, Buffalo, New York

This article is a description of equipment that is being used in the photographic department of the State Institute for the Study of Malignant Diseases. It is a copying and reducing apparatus, as a whole, not original. However I am passing it on to those who have to do the best work in the shortest possible time.

The apparatus is described in detail so those who wish to build one similar can do so. The bed, *A*, is 7 feet long by 14 inches wide. The

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side boards are made of oak. Hard wood is necessary because of the constant wear. There is a groove on the inner surface of the side boards, at the edge, measuring $\frac{1}{4}$ inch wide and $\frac{3}{4}$ inch deep. The bottoms of each part, *B*, *C* and *D*, are cut so that they fit into this slot, thus allowing each part to slide easily. The distance between the floor and the top of the bed is a matter of choice. In the center of the bed there is a compartment which in figure 1 shows two 5 x 7-inch film holders in a vertical position. This compartment is 12 inches wide, 41 inches long and 4

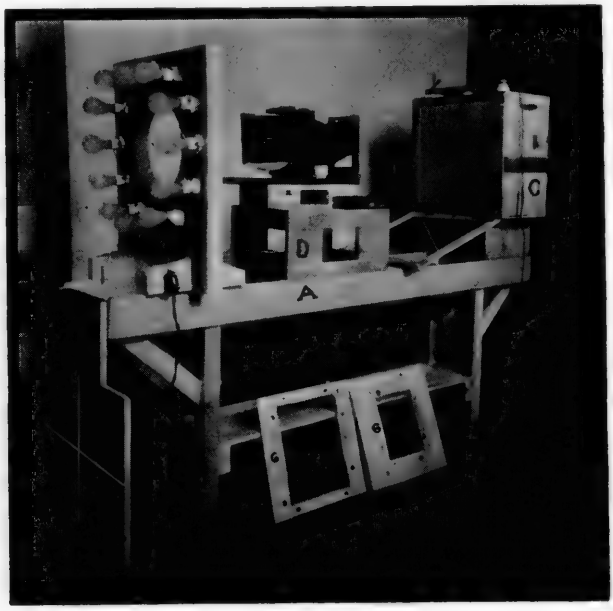

FIG. 1

inches deep. It makes an excellent receptacle to keep unexposed and exposed film holders in, also unfinished work that is being done. The exposed plates are generally placed under *D* when completed so that they will not be reëxposed by mistake. The shelf below is used for kits (*G*), extension cords and the light arrangement *B* when not in use. It is a very convenient place to put films when finished as this will separate the finished from those which have not been exposed. *B* is the lighting arrangement which is used in copying drawings for other pictures. Several lights of about 60 watts are mounted on this surface and hooked

up in parallel. The lights are connected in this manner so that one or two may be unscrewed when they are the cause of a reflection on the copy. By making this adjustment the distribution of light is not impaired. The lights arranged in this way also help in dodging a picture when even illumination is not wanted. The exposure is made through a 12-inch circle.

Before copying a picture study the subject from the place where the camera is to be so that a lens view of the photograph is obtained. The lights are then moved backward or forward until the desired lighting effect is obtained. *B-1* is the copy board which is on a hinge and is made of soft wood so that a thumb tack can easily penetrate it. It is scored with a sharp instrument into $\frac{1}{2}$-inch graduations and a center line is marked both horizontal and vertical so the copy can be easily centered. These parallel lines, $\frac{1}{2}$-inch apart, readily show when the copy is straight. Not only can this copy board be used but a larger one can be placed on the wall and the entire apparatus, which is on casters, be moved up to the desired distance. The camera bed must be 90° to the copy board in order to avoid distortion. Many times the print to be copied is already distorted, however, by pushing the end of the apparatus either to the left or right will make the drawing lines parallel. The same can be done with the copying board *B-1* which swings on a hinge. It can also be raised to the proper elevation to prevent distortion.

The box-like arrangement *C* is used to illuminate a radiograph or transparency for the purpose of making a positive or negative enlargement or reduction. It consists of a metal lined box 24 inches square, outside dimension. The inside of the box is painted with aluminum paint to help eradicate shadows from wires and sockets. There are nine 60-watt lights in the box although stronger ones may be used. These lights are placed in rows of threes. There are three switches located on the top of the box which makes it possible to cut down the light when necessary or to brighten it in some places and reduce it in others. There is a frame on a hinge, directly in front of the box which contains a plain piece of glass. This is used to hold the kits for different size films. These kits (*G*) are made from cardboard cemented together by dry mounting tissue and are 17 inches square. This allows them to be used either horizontally or vertically. An opening is cut in them allowing $\frac{1}{4}$ inch border so that they can hold any size film. The most common ones used are the standard size x-ray film. These kits are very im-

portant for they prevent halation around the edges of the copy. The illuminator is placed on the bed of the copier and can be slid backward or forward to give the desired size picture.

There is still another use for this illuminator, viz., photographing gross specimens which demand special lighting in order to bring forth the desired detail. Many photographers submerge the specimen in water or kerosene oil. This method is objectionable because the specimen often floats to the surface and it may also cause discoloration of the liquid used. To obviate these difficulties we photograph the specimen placed on the illuminator. The illuminator is then turned on. This allows a sufficient amount of light to come through to obliterate the shadows from the side lights. By using this method it is not necessary to block out the back grounds or use a new back ground for each picture as it is just a matter of washing off the opal glass and you are ready for the next picture. Better results are generally obtained if all exposures are made in a dark room using nothing but artificial light. Standardize the exposure time for certain stops. It is then just a matter of using the multiplying factor to the exposure when using the different filters necessary for the gradation of blacks and whites desired. This is a great time saver. The smaller the diaphragm stop, the greater the detail and depth of focus. It seems foolish to mention this but many who should know better fail to follow this rule. It does not matter if a long exposure is made as there is little possibility of anything moving.

To the right and left of this set up, two lights (Fotolite) are used. These lights supply the direct lighting and are obtainable in different wattages, however, the use of the same amount of light for each exposure is suggested in order to standardize the procedure.

It may occur to you to inquire about reflections from a specimen that is fresh. On each light there is a handle. By having an assistant and yourself each work a light keeping them moving in a half circle, you will get even illumination with no reflections or high lights.

If the specimen is old and has been fixed for some time, allow it to soak in a bath of 85 to 95 per cent alcohol for thirty minutes. All the color that can be restored will appear at this time although the color will gradually fade and it will not be possible to restore it as well the second time.

BOOK REVIEWS AND ABSTRACTS

By JAMES R. DUNLOP, JR.

BIBLIOGRAPHIC REFERENCES TO PHOTOGRAPHY

The following list of references on photography has been compiled from the *Quarterly Cumulative Index of the Index Medicus* and from the *Surgeon General's Catalogue.* It is purely an index of articles appearing mainly in the medical literature. The biological photographer should find them a valuable source of reference for his own information as well as an essential aid in preparing articles for publication.

It is most desirable that all articles appearing in this JOURNAL be accompanied by a reference list or bibliography. Every author should review articles that have been written on the subject he intends to write about, before he writes.

Each reference is compiled in the following manner: (1) the name of the author; (2) the title of the article or book; (3) the name of the journal in which the material has been published; (4) the year of publication; (5) the volume; (6) the inclusive paging. The references are listed according to date of publication, the oldest material being given first. In those articles that were published in 1927 or later, the arrangement differs from that given above in the following way: (1) the name of the author; (2) the title of the article or book; (3) the name of the journal in which the material has been published; (4) the volume number; (5) the inclusive paging; and (6) the year of publication. Notice that in the latter arrangement the last three steps are different.

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(Continued in June issue)

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June, 1933

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VOLUME I *June, 1933* NUMBER 4

The Journal of the Biological Photographic Association

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EDITORIAL

The program committee of the Biological Photographic Association wishes to remind you that the third annual convention of the Society is to be held in the early fall.

The Committee especially wishes to emphasize that these are your meetings. In the formulating of the program your suggestions as to what papers would be most helpful, and what subjects would promote the most interesting discussion, would be greatly appreciated. The Committee welcomes your comment. Furthermore, if you care to submit a paper or have your name appear as leading in discussion, you are at liberty to do so. In such a case kindly send your name and the title of your paper to Mr. Ralph P. Creer, Veterans Administration, Hines, Illinois. If perchance you know of some one who may have interesting material that might be presented at the convention this also would be greatly appreciated, and would be given every consideration.

Insomuch, as we plan to publish the proceedings of the convention, this request applies, not only to members who expect to be present, but also to those who are so geographically situated that it would be impractical to attend.

The arrangements for the program are to be made as soon as possible, therefore, we would appreciate receiving such suggestions at an early date. All non-members of this association who are interested in biological photography are cordially invited to attend the convention.

A PHOTOELECTRIC EXPOSURE METER FOR PHOTOMICROGRAPHY*

LOUIS GROSS, M.D. AND C. A. JOHNSON

From the Laboratories of The Mount Sinai Hospital, New York, N. Y.

INTRODUCTION

After the photomicrographer has properly prepared a slide of the specimen to be photographed, and has it set-up in his apparatus so that a satisfactory image is formed on the ground glass plate, he is still confronted with the problem of the length of exposure time required to produce the best negative and the proper time for development of the negative in order to correct for inaccurate exposures. The length of exposure of a photographic plate is an inverse function of the amount of actinic light incident upon it, according to well known photographic formulae. The amount of actinic light, in turn, is dependent upon many variable factors in the set-up such as the magnification, the aperture of the iris diaphragm, the stain used on the specimen, the thickness of the section, the light filter employed to bring out the proper detail, etc.

An experienced photographer has usually accumulated a sufficient amount of more or less empirical data to enable him to estimate the exposure time necessary in any particular case. In any event, it can be determined by trial and error. This, however, involves a waste of time and materials, even for the expert, and would be a hopelessly involved procedure for the novice. On the other hand, it is often necessary, in biological laboratories, hospitals, etc., for those who are not expert to be able to make first class photomicrographs.

This condition gives rise to the need for some form of apparatus which will give an accurate objective measurement of the actinic light in the plane of the photographic plate. Once such an instrument has been properly calibrated, subsequent measurements can be interpreted in terms of exposure time. Under such conditions it becomes possible to employ time-temperature development of negatives, thus eliminating the necessity of correcting for inaccurate exposures. It is the purpose of this paper to describe the theory and use of an exposure meter designed to permit of accurate standardization of photomicrography.

Since the use of photoelectric cells for the measurement of light in-

* Aided by a grant from the Lucius N. Littauer Foundation.

tensity has proved entirely satisfactory in problems similar to this one, the photoelectric method was selected as a solution. A condensing lens was placed in the plane of the photographic plate to collect the light from the entire image to be photographed or from a part of it.[1] The cell was then placed near the focus of this lens so that the reduced image was entirely intercepted by the active surface of the cell. The arrangement of this part of the apparatus is shown schematically in figure 1. The distance, D, will vary depending upon the objective lens used in the

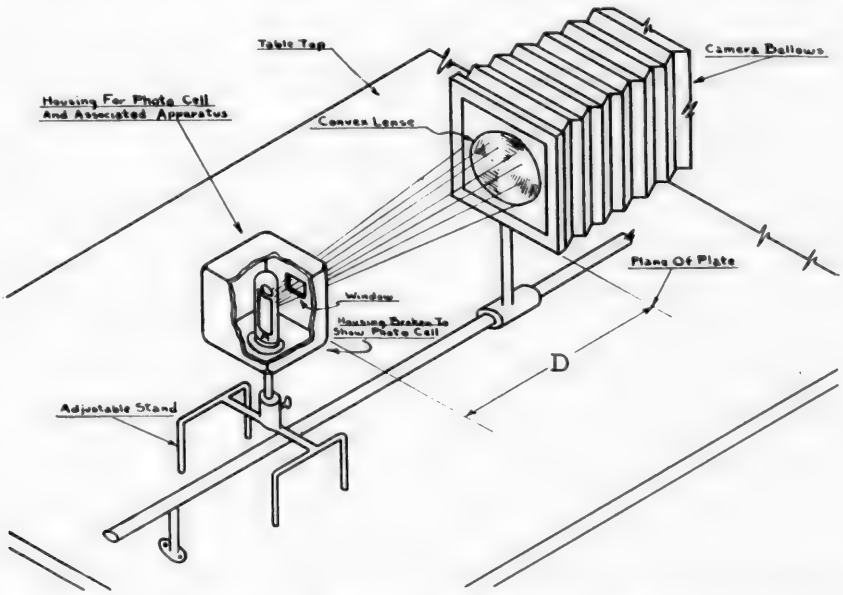

FIG. 1. DIAGRAM SHOWING THE LOCATION OF THE "DETECTOR" UNIT OF THE EXPOSURE METER WITH REFERENCE TO THE CAMERA

microscope, so that it is necessary to have the cell support moveable along the horizontal axis. The stand permits adjusting for height, and rotating the housing about the vertical axis so as to obtain the maximum illumination on the cell. Since the equipment under discussion was designed for use with different types of microscopic apparatus, the cell mounting was made independent of the optical track. For a permanent

[1] In order to obtain a true reading of the actinic value of the light actually passing through the tissue only, a simple technique to be described below was employed.

set-up on one type of apparatus it would perhaps be simpler to design this mounting to fit on the track itself.

The ideal photoelectric cell for this equipment would, of course, be one having spectral sensitivity identical with that of the photographic plate. It would be rather difficult to realize this ideal in practice, particularly since several different types of plates may be used. The best we can do, therefore, is to select a cell which has reasonably uniform sensitivity over the photographic range, and which does not have any pronounced peaks outside this range.

Photomicrographic technique generally involves the use of filters which limit the spectral region to be measured. Since some of these filters are of the "high pass" type, it is important to select a cell having a threshold above the cut-off point of the filter going the farthest into the red end of the spectrum. If the response of the cell beyond the actinic region is too great, (i.e. if the photoelectric threshold is too high), the actinic energy will be only a small per cent of the total energy measured. Under such conditions, in order to sufficiently differentiate between varying amounts of actinic energy, it may be necessary to use a "low pass" filter in front of the cell, (or elsewhere in the optical path), to cut down the infra-red response.

In the equipment under discussion we have used a caesium cell without any permanent filter, for obtaining our preliminary data. Subsequent experiments may demonstrate that some other type of cell is more suitable.

DESCRIPTION OF THE CIRCUIT

In the set-up described above, the lowest light intensity measured gave a photoelectric current of the order of 10^{-9} amperes. Since we desired to make our exposure meter portable and rugged it was necessary to amplify this relatively feeble current, so that it could be read on a microammeter.

The problem of amplifying photoelectric currents has been adequately discussed by a number of experimenters (1, 2, 3). A discussion of the details of this problem is beyond the scope of this paper. The circuit used is simply an application of standard technique with careful attention to details of design and construction, so as to obtain the stability and accuracy required in this type of work. A brief discussion of the cir-

cuit used, however, will serve as a means of pointing out the possibilities and limitations of the instrument.

The photoelectric cell was coupled to a single stage direct current amplifier as shown in figure 2. The letters on the drawing refer to the following elements in the circuit.

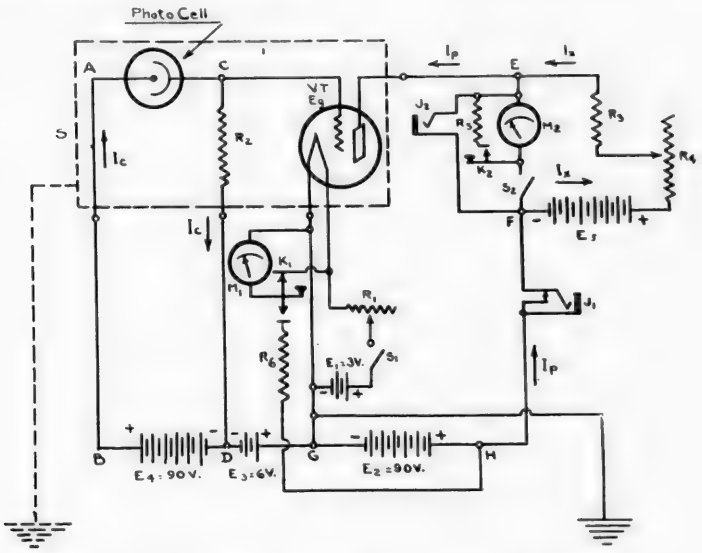

FIG. 2. CIRCUIT DIAGRAM OF EXPOSURE METER
See pages 4 and 5 of the text

E_1.....Filament battery.
E_2.....Plate battery.
E_3.....Grid biasing battery.
E_4.....Photo cell battery.
E_5.....Balancing battery for output meter.
R_1.....Filament rheostat.
R_2.....Coupling resistor.
R_3.....Fixed resistor in series with balancing battery.
R_4.....Variable resistor in series with balancing battery for obtaining zero setting.
R_5.....Meter shunt to increase range by a factor of ten.
R_6.....Resistor for increasing range of filament voltmeter so that it will measure plate voltage.
M_1.....Double scale voltmeter for measuring filament and plate voltage.
M_2.....Output meter.

S_1.....Filament switch.
S_2.....Output meter switch.
K_1.....Push button at bottom of filament voltmeter to be depressed for reading plate voltage.
K_2.....Push button for opening meter shunt circuit to increase sensitivity of output meter by a factor of ten.
J_1.....Closed circuit jack for measuring total plate current with external meter when necessary.
J_2.....Open circuit jack connected in parallel with meter to be used for an external meter of different range, if necessary.
S.....Electrostatic and electromagnetic shield consisting of photo cell housing and shield on cable.
V. T.....Three element vacuum tube.

The elements enclosed by the broken line marked, S, are housed in a $4\frac{1}{2}''$ x $4\frac{1}{2}''$ x $5\frac{1}{2}''$ metal box shown as the photo cell housing in figure 1. The front of this housing is fitted with a window and shutter so that light may be admitted to the photo cell.

The remainder of the circuit including all battery supply is contained in a leather covered instrument case 16″ long x 7″ wide x 14″ high. The top of the case is a hinged cover fitted with a folding leather handle for carrying, and secured by two trunk catches. When the cover is opened, the bakelite instrument and control panel is exposed for operation. The arrangement of the instruments on this panel is shown in figure 4. The marking on the instrument panel corresponds to the legend for figure 2, with the exception that J_1 is marked P.C. and J_2 is marked E.M.

The theory of the operation of the circuit is briefly as follows.

When S_1 is closed so that current flows through the filament and heats it beyond a certain minimum temperature, electrons are emitted according to the well known "Edison effect." If S_2 is now closed the plate of the tube has a positive charge with respect to the filament due to the battery E_2. For the sake of simplicity we will disregard, for the moment, the presence in the circuit of R_3, R_4 and E_5. When the plate is charged positive the electrons from the filament are attracted to the plate and a stream of electrons flow downward through M_2 and R_5, J_1 and through E_2 back to the filament. Since the term "electric current" as used in the conventional manner implies an electrical disturbance in a direction *opposite* to that of the electron flow, we then have in the case cited above a plate current of intensity, I_p, let us say, flowing upward through M_2 and R_5 and around through the tube from plate to filament in the

direction indicated by the arrow. Hence, M_2 will indicate a current reading I_p.

The "control grid," which is the element between the filament and the plate in the vacuum tube, can be made to control I_p. For example, if the grid is charged positive with respect to the filament by means of the battery E_3 it will accelerate the flow of electrons to the plate, (i.e. it will increase I_p), and vice versa. In practice E_3 is usually a battery of a few volts hooked in the circuit as indicated, so that E_g, the grid potential, is slightly negative with respect to the filament. The exact manner in

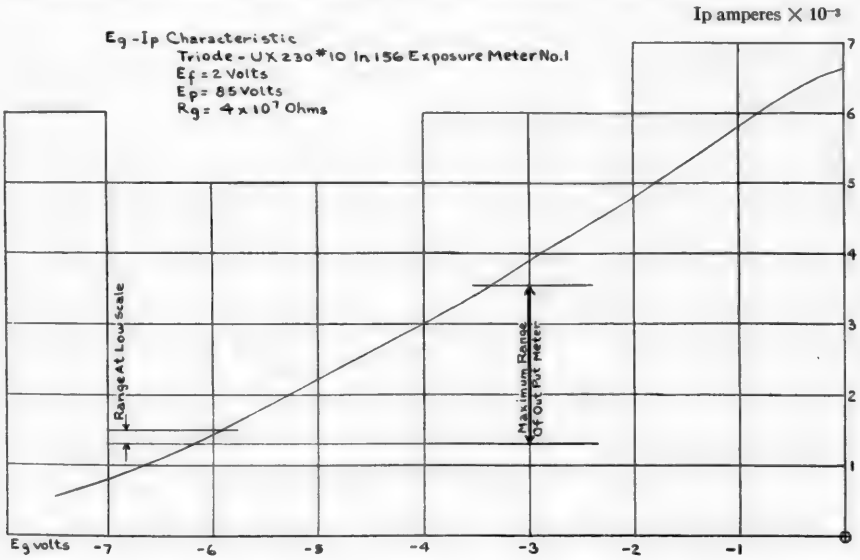

FIG. 3. DIAGRAM SHOWING THE ARRANGEMENT OF THE INSTRUMENT PANEL OF THE EXPOSURE METER

which E_g controls I_p, in a typical case, is shown by the E_g—I_p characteristic of figure 3.

Thus we see that for any change in grid voltage, ΔE_g, we have a corresponding change in plate current, ΔI_p. These factors are related by the following general equation.

$$\Delta I_p = \frac{\mu \Delta E_g}{R_p + R_o} \tag{1}$$

where R_p = the plate to filament resistance of the tube.

R_0 the resistance in the part of the plate circuit outside of the tube.

μ = the "voltage amplification factor" and is defined by the equation

$$\mu = -\frac{d\,E_p}{d\,E_g}\Bigg]\, I_p = \text{constant}$$

In the circuit under consideration, R_0 is very small compared to R_p so we may disregard this factor in equation (1), and re-write it as

$$\Delta I_p = \frac{\mu\,\Delta\,E_g}{R_p} \tag{2}$$

The quotient $\frac{\mu}{R_p}$ is defined as the "mutual conductance" of a triode, and is designated by the symbol G_m. Hence equation (2) may also be written

$$\Delta I_p = G_m\,\Delta\,E_g \tag{3}$$

Consider now the photoelectric cell circuit ACDB. First let us consider the case where the cell is in darkness so that the current through the cell, I_c, is a minimum and is constant. Now if light is admitted into the cell, electrons are discharged from the cathode, C, and are attracted to the anode, A. Thus there is an increase in current through the cell equal to ΔI_c in the direction indicated by the arrow. This increases the potential of the grid by an amount

$$\Delta E_g = \Delta I_c\,R_2 \tag{4}$$

Hence we can combine equations (3) and (4) so that we have an expression for ΔI_p in terms of ΔI_c as follows:

$$\Delta I_p = G_m\,\Delta I_c\,R_2 \tag{5}$$

We can apply this formula to a numerical example to determine the order of magnitude of ΔI_p for the minimum light intensity involved in the set-up described above. The following constants apply to this apparatus

G_m = approximately 700×10^{-6} mho
$\Delta I_c = 10^{-9}$ amperes approximately
$R_2 = 4 \times 10^7$ ohms

Substituting in (5)

$$\Delta I_p = 7 \times 10^{-4} \times 10^{-9} \times 4 \times 10^{7}$$
$$= 28 \times 10^{-6} \text{ amperes}$$
$$= 28 \text{ microamperes}$$

Hence the reading on M_1 would increase by 28 microamperes. However, in practice this tube must be operated at a plate current of about 1.5×10^{-3} amperes so that if M_1 had sufficient range to carry the original I_p, a ΔI_p of 28×10^{-6} amperes would not be readable on its scale. We must overcome this difficulty by "balancing out" the normal I_p by means of the battery, E_5. At this point in the discussion, let us introduce into the circuit, the elements R_3, R_4 and E_5.

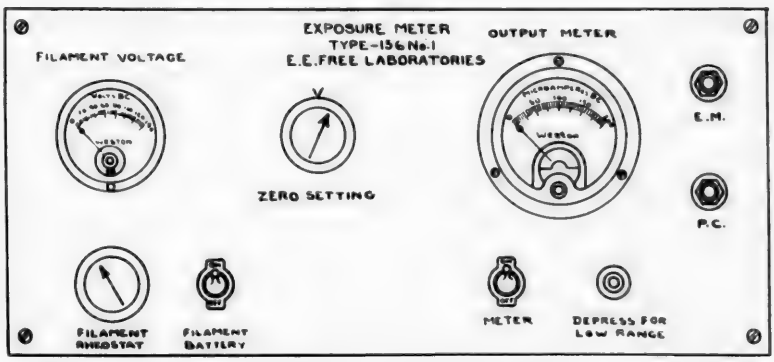

FIG. 4. GRID VOLTAGE-PLATE CURRENT CHARACTERISTIC OF VACUUM TUBE USED IN EXPOSURE METER SHOWING THAT THE RESPONSE IS ESSENTIALLY LINEAR OVER THE RANGE CONCERNED

Suppose we have a normal plate current, I_p, of 1.3×10^{-3} amperes, flowing *upward* through M_2 and R_5 as indicated by the arrow. The polarity of E_5 is such that it will tend to cause a current I_x to flow *downward* through M_2 and R_5 in the direction indicated by the arrow. The intensity of I_x is given by the formula:

$$I_x = \frac{E_5}{\left(R_3 + R_4 + \dfrac{R_5 M_2}{R_5 + M_2}\right)}; \quad M_2 = \text{resistance of meter} \qquad (6)$$

When $I_x = I_p$, M_2 will read zero, because $I_p + (-I_x) = 0$. Adjustment for zero can be made by varying R_4 which is the zero setting dial on the control panel.

In practice it will be found that in order to get the proper combination of range and accuracy of control, R_3 should be about $10R_4$ and both should be large compared to $\frac{R_5M_2}{R_5+M_2}$. In the apparatus under discussion, $\frac{R_5M_2}{R_5+M_2} = 10$ and the other two resistances were given the values:

$$R_4 = 5000 \text{ ohms}$$
$$R_3 = 50{,}000 \text{ ohms}$$

Using these values and setting $I_x = 1.3 \times 10^{-3}$ amperes when R_4 is set in the center of its travel we can compute the value of E_5.

$$E_5 = 1.3 \times 10^{-3} \times 50{,}000 + 2500$$
$$= 1.3 \times 52.5 = 68.5 \text{ volts}$$

This permits a voltage variation of $1.3 \times 10^{-3} \times 2.5 \times 10^{3} = 3.25$ volts on either side of zero to compensate for gradual variations in either E_2 or E_5.

Now that the current through M_1 is zero we can remove it, so to speak, and replace it by a sensitive microammeter which will give a readable indication of the smallest values of ΔI_p due to the lowest light intensities to be measured.

In the apparatus which we are describing, M_1 has a full scale range of 0–200 microamperes with 40 scale divisions so that the lowest readable ΔI_p is 5 microamperes with a possibility of estimating to 2.5 microamperes with reasonable accuracy. Since the range of light intensities to be measured may be, in extreme cases, as great as 500 to 1, the value of R_5 is chosen so as to multiply the range of the meter by a factor of ten, thus giving an accurately readable range of

$$\frac{200 \times 10^{-6} \times 10}{5 \times 10^{-6}} = \frac{400}{1}$$

with a possibility of doubling this range by estimating the midpoint between scale divisions. This shunt is always in circuit to protect M_1 except when K_2 is depressed for the purpose of using the lower range of the meter.

We will now summarize the practical operation of this circuit in a set of operating instructions.

OPERATING INSTRUCTIONS FOR TYPE 156 EXPOSURE METER

To place the meter in operation, proceed as follows:

1. Open the cover of the instrument case and note that all the switches are in the "off" position.
2. Connect the two binding posts on the left end of the case to a good ground such as a cold water pipe.
3. Connect the photo cell housing to the instrument case by inserting the 5-prong plug into the receptacle on the left hand end of the case.
4. Check the plate voltage by depressing the push button at the bottom of the filament voltmeter. The plate voltage is read on the upper scale of this meter (0–140). It should not read less than 82.5 volts and it may read as high as 90 volts.
5. Close the filament circuit by turning the toggle marked "filament battery" to the "on" position.
6. Adjust the filament voltage to 2 volts on the lower scale of the filament voltmeter, (0–7), by means of the rheostat underneath the filament voltmeter. It may take a few seconds for the filament voltage to stabilize. Care should be taken not to increase this voltage much above 2 volts, because it will shorten the life of the tube.
7. Close the shutter on the photo cell housing and note that the housing is not exposed to any extremely intense light.
8. Close the meter switch, and note whether the output meter is reading above or below zero.
9. Set the meter to zero by means of the rheostat marked "zero setting."
10. If the shutter is now opened, and the cell exposed to a moderately intense light, such as a flash light held a foot or two from the window, the meter should give a noticeable deflection. This indicates that the circuit is working.
11. Adjust the photomicrographic apparatus so that the image of the specimen is properly focused on the ground glass plate at the back of the bellows.
12. Replace the ground glass with the condensing lense.
13. Close the shutter on the photo cell housing and place the latter about 30″ from the condensing lense.

14. Adjust the distance and the height of the photo cell stand so that an image about $\frac{1}{4}''$ in diameter falls just above the center of the shutter.
15. Open the shutter and make sure that the image falls entirely on the plate of the cell.
16. Make final adjustment for maximum sensitivity by rotating the photo cell housing slightly about a vertical axis and noting at what point the meter gives a maximum deflection.

    Note: For any magnifications greater than the 100 mm objective it will be necessary to use the low range of the meter. To do this follow instructions in ¶ 17.
17. Close the shutter. Leave the room lights turned off so that the photo cell housing will be kept fairly dark. Using a flashlight, set the meter on the low scale. This is done either by depressing the push button under the output meter, or by moving the toggle marked "low-high" to the low position, depending upon which equipment is furnished with the meter you are using.
18. Re-adjust the meter for zero on the low scale (which is slightly different than the zero on the high scale).
19. With the meter set at zero and the photo cell in proper focus, make a measurement of the light intensity by opening the shutter and noting the meter reading. In making any measurement in which the range of intensity of the light is unknown, it is always advisable to make a preliminary reading using the high scale. If this reading is under 20, the low scale should be used for greater accuracy.
20. In making any particular measurement it is advisable to repeat the reading about 3 times, closing the shutter and checking the zero point each time. These readings should agree to within 1 or 2 microamperes.
21. When the meter is to be turned off *always turn the meter switch off first.* If the filament switch is turned off first the entire output of the balancing battery will be thrown upon the meter and such treatment may injure it even when it is on the high scale. *Under no circumstances should the filament circuit be turned off when the meter is on the low scale for this would certainly result in the distruction of the meter.* The best procedure is to always turn the *filament on first* and *off last.*

Maintenance

1. Zero drift. Since the plate battery and the balancing battery are independent of each other there will be some drifting of the zero point on the meter due to unequal fall in the potential of each set. Since these two sets of batteries are exactly similar, as far as current capacity is concerned, and since they have practically the same current drain, the rate of decrease in potential will be very nearly the same for each. As long as the independent drift is not great enough to materially change the zero while a single reading is being taken, there will be no decrease in the accuracy of the reading. The sensitivity of the circuit is dependent upon the slope of the E_g—I_p characteristic, which is constant over a considerably greater range than that covered by the output meter. The act of balancing the meter to zero simply shifts the operating point very slightly up or down along this curve. If after having been set to zero, the meter has a tendency to always drift rapidly up the scale, the balancing battery is falling off rapidly. In that event it should be replaced. If on the other hand the meter always drifts *below* zero, and if the filament voltage is constant, the chances are that the plate battery needs replacement. This can be checked further by means of the plate voltmeter.

If the meter has negligible drift, and still the range of adjustment of the zero setting rheostat is insufficient to bring the needle to zero, this difficulty can be corrected by shifting the balancing battery voltage on the taps provided for this purpose. If the meter always reads above zero the balancing battery voltage must be increased. If the meter always reads below zero the balancing battery voltage must be diminished. Whenever such an adjustment is being made, make sure that the meter switch is in the "off" position.

If a milliammeter of from 2 to 10 milliamperes range is available it can be plugged into the jack marked P. C. and the total plate current measured. Then, the exact value of balancing battery voltage required can be computed by the formula

$$E_b = I_p \times 52500$$

2. Filament battery. It is important to keep the filament voltage at 2 volts at all times. Any appreciable departure from this value will change the sensitivity of the circuit. When the voltage can no longer be brought up to 2 volts, the filament battery must be replaced.

3. Plate battery. If the plate battery is allowed to decrease much below 85 volts it is apt to change the sensitivity of the circuit. For greatest accuracy, then, these batteries should be replaced when they have decreased to this amount.

4. Conservation of batteries. The length of service obtainable from the battery supply can be increased materially if the filament battery is turned off whenever it is to be out of service for a period longer than 5 minutes.

Remember, however, to always turn the meter off first.

5. Extraneous light. The photo cell housing is not absolutely light tight, and the window is not a very efficient collimator; therefore, the housing should be kept in reasonable darkness or at least in constant illumination when measurements are being made. This can easily be checked, of course, by noting the effect of stray light on the reading of the meter.

6. Leakage current. One of the common difficulties of high sensitivity direct current amplifiers of this type is leakage current in the grid circuit. Care should be taken, therefore, to keep the photo cell housing free from dust and moisture.

7. Stray electric fields. Although the apparatus is fairly well shielded, it is possible for strong electrostatic or electromagnetic fields to affect the behavior of the instrument. If the meter is erratic in behavior when the shutter is closed and the cell housing is shielded from intense light, the trouble may be due to electric pick-up. This can be checked by moving the instrument with respect to any nearby electric apparatus, or by disconnecting such apparatus. If these changes change the meter reading, the difficulty is due to the presence of the electric apparatus. If it is necessary to operate the exposure meter in close proximity with such disturbances, the trouble can usually be corrected by shielding the electrical apparatus. In general, for the best results the exposure meter should be set-up as far away as possible from any high voltage alternating current apparatus, such as an X-ray tube. We have experienced no such difficulties in our present set-up.

8. External meter jack (jack marked E. M. on panel Fig. 3). This jack is provided for the purpose of replacing the output meter with an external meter either for checking the former or for obtaining greater sensitivity by using a meter of lower range than 200 microamperes. When an external meter is used, the meter switch should be left in the "off" posi-

tion. An external meter of higher range than the 0–2 milliamperes may be used in this jack for indicating when balancing battery voltage is correct. It is not advisable, however, to attempt to measure light levels higher than full scale deflection on the high range of the output meter. In the first place, such data would be inaccurate because of appreciable change in the slope of the E_g—I_p characteristic. (See figure 3.) Furthermore greater light intensities are apt to injure the photo cell. As a matter of fact, very high intensities may damage the cell even when it is disconnected from the circuit and no voltage is applied to it.

9. Plate current jack (jack marked P. C. on panel). This jack is provided for the purpose of checking the total plate current of the tube. This must be done with the meter switch on, or with an external meter of 0–5 milliamperes (or more) range in the E. M. jack. (See figure 2.)

PRELIMINARY CALIBRATION DATA

It was mentioned above that in order to obtain an accurate reading of the actinic value of the light penetrating the tissue on the microscopic slide it is necessary to obtain a measure of the light which passes only through this tissue and not around the specimen. For example, if a light reading should be made of a specimen containing many empty spaces the total reading would represent the sum of light coming through these spaces (quite large) together with the reduced amount of light coming through the actual tissue. There would be no way, therefore, of arriving at the actual factor representing the density of the tissue itself. In order to overcome this, one first selects a field in which the tissue solidly covers the entire ground glass enclosure eventually to be photographed. In other words, this field should be selected to contain as little empty space (i.e., devoid of tissue) as possible. The ground glass is then replaced by the light collecting lens. The amount of light penetrating this field gives one a measure of the actual density of the tissue itself. Having obtained this light reading the collecting lens is removed, the ground glass replaced and the specimen is now moved into the actual position in which it is desired to be photographed. A simple calculation of the reading obtained will give the exact time of the exposure (vide infra).

When the magnification used is so low that it is impossible to cover the entire field with more or less solid tissue, a mask bearing a circular aperture in its center (we have employed a circular opening 3 cm. in diameter for this purpose) is placed behind the ground glass. It is generally

possible to find a "solid" field of tissue large enough to cover this aperture. The light reading is then obtained in the usual manner, the mask removed and a photograph taken based upon this arbitrary reading obtained through the standard sized orifice.

Obviously, all exposures are originally based on the time which experience has shown is correct for a given light value. Once this time-light ratio is determined under standard conditions as to stain, filter and size of mask, all other exposures can be calculated therefrom.

With these points in mind experimental observations on light readings were made from slides of myocardium stained with Hematoxylin and Eosin, Masson's Erythrosin Saffron, Trichrome Green and Trichrome Blue, Mallory's Phosphotungstic hematoxylin, Weigert's Elastica and Van Gieson's connective tissue stain and Papp's silver reticulum stain. Three slides were selected for each stain, representing thick, average and thin sections. For proper contrast in photography, Eastman Kodak Wratten M-2 filters were used as indicated in table 1. Readings and exposures were made on each of these slides employing objectives ranging in aperture from 100 mm. to 2 mm. The exposed plates were developed in the following solution, using 96 cc. of the diluted developer for each plate. For purposes of standardization fresh developer was used for each plate.

Metol	13.0 grams
Sodium sulphite	170.0 grams
Hydroquinone	20.0 grams
Sodium carbonate	78.0 grams
Potassium Bromide	5.0 grams
Water	3,785 cc.

Mix the chemicals in this order. Dilute one part of developer with two parts of water.

The plates used were Gevaert Sensima Orthochrom Anti Halo. These give a grade of contrast generally found desirable for photomicrography. The developing time was four minutes at 68 degrees F.

For each new combination of stain and filter it was necessary to obtain the proper time of exposure by actual trial and error. In this way a definite correlation was found between the photometer reading and the proper time of exposure. Once this was obtained, any magnification or density of tissue was found to bear a simple inverse ratio to the photometer reading granted that the stain, filter quality of light and area of

light read remained the same. It was thus possible to set up very simple tables from which one can determine the correct exposure for any given slide stained by these methods.[2] For example (table 1) it was

TABLE 1

Thick, normal and thin sections of myocardium stained with hematoxylin and eosin

SLIDE NUMBER	OBJECTIVE	FILTER	METER READING	EXPOSURE
				seconds
6852	2 mm. oil	Green B F 58	4	113
864	2 mm. oil	Green B F 58	7	64
5590	2 mm. oil	Green B F 58	7	64
6852	4 mm.	Green B F 58	10	45
864	4 mm.	Green B F 58	15	30
5590	4 mm.	Green B F 58	20	22
6852	8 mm.	Green B F 58	24	20
864	8 mm.	Green B F 58	26	18
5590	8 mm.	Green B F 58	30	16
6852	16 mm.*	Green B F 61	4	13
864	16 mm.*	Green F B 61	6	8
5590	16 mm.*	Green B F 61	6	8
6852	25 mm.*†	Green B F 61	6	8
864	25 mm.*†	Green B F 61	7	7
5590	25 mm.*†	Green B F 61	8	6
6852	35 mm.*†	Green B F 61	7	7
864	35 mm.*†	Green B F 61	8	6
5590	35 mm.*†	Green B F 61	9	6
6852	75 mm.*†	Green B F 61	8	6
864	75 mm.*†	Green B F 61	9	6
5590	75 mm.*†	Green B F 61	10	5
6852	100 mm.*†	Green B F 61	9	6
864	100 mm.*†	Green B F 61	12	4
5590	100 mm.*†	Green B F 61	13	4

* For objectives ranging from 16 mm. to 100 mm., a mask bearing a circular aperture 3 cm. in diameter was employed for the meter readings.

† For objectives ranging from 25 mm. to 100 mm., the light intensity was reduced by means of a rheostat.

found that slide # 864 stained with Hematoxylin and Eosin, employing green filter BF 58 required 30 seconds to give the correct exposure under

[2] If plates of different sensitivity are used a simple correction factor can be obtained which may be applied to the figures in these tables.

magnification by a 4 mm. objective (fig. 5, B). The photometer reading under these conditions was 15. Slides #6852 and #5590, also stained with Hematoxylin and Eosin and photographed with green filter BF 58 gave photometer readings of 10 and 20 respectively. In order to obtain the correct exposure time for these, the photometer reading obtained by the original trial and error experiment (i.e., 15) is divided by the new photometer readings obtained from the slides to be photographed, and multiplied by the time found correct for slide #864 (i.e., 30 seconds). The results obtained are 45 and 22.5 seconds respectively. Exposures taken with this amount of time (fig. 5, A and C) gave a perfect photographic result. This simple light-time ratio is observed in figure 5, D, E and F, which represents sections #6852, #864 and #5590 stained with Hematoxylin and Eosin and photographed with a 16 mm. objective employing green filter BF 58.

Figures 6 and 7 represent average and thin sections of myocardium stained by the Papp silver reticulum method, photographed with the 4 mm., 8 mm., 16 mm. and 25 mm. objectives respectively, employing yellow filter GF 15. Even though the light value of these slides varied considerably, uniformly excellent results were obtained by the employment of the simple formula mentioned above.

In the 16 mm., 25 mm., 35 mm., 75 mm. and 100 mm. objectives, two additional variables were introduced, viz., the mask and reduction of light intensity at its source. These exposures were made using a 500 watt incandescent bulb in series with a rheostat. For lower magnification the rheostat was thrown into the circuit. This alters the quality of the light, introducing a relatively large amount of rays towards the red end of the spectrum. The light-time ratio is thereby affected but again this can easily be determined by trial and error. Simple tables, such as those submitted here, make it possible to take correct exposures even with these variables introduced.

It is obvious that with this method it is no longer necessary to develop plates individually and to estimate the correct time for optimum development of the image. With a standardization of the light value it is recommended that only time-temperature development should be employed.

It is hoped that this simplification of photomicrography will stimulate a much wider interest in this field. By the use of this instrument[3] it is

[3] Constructed by the E. E. Free Laboratories, New York City.

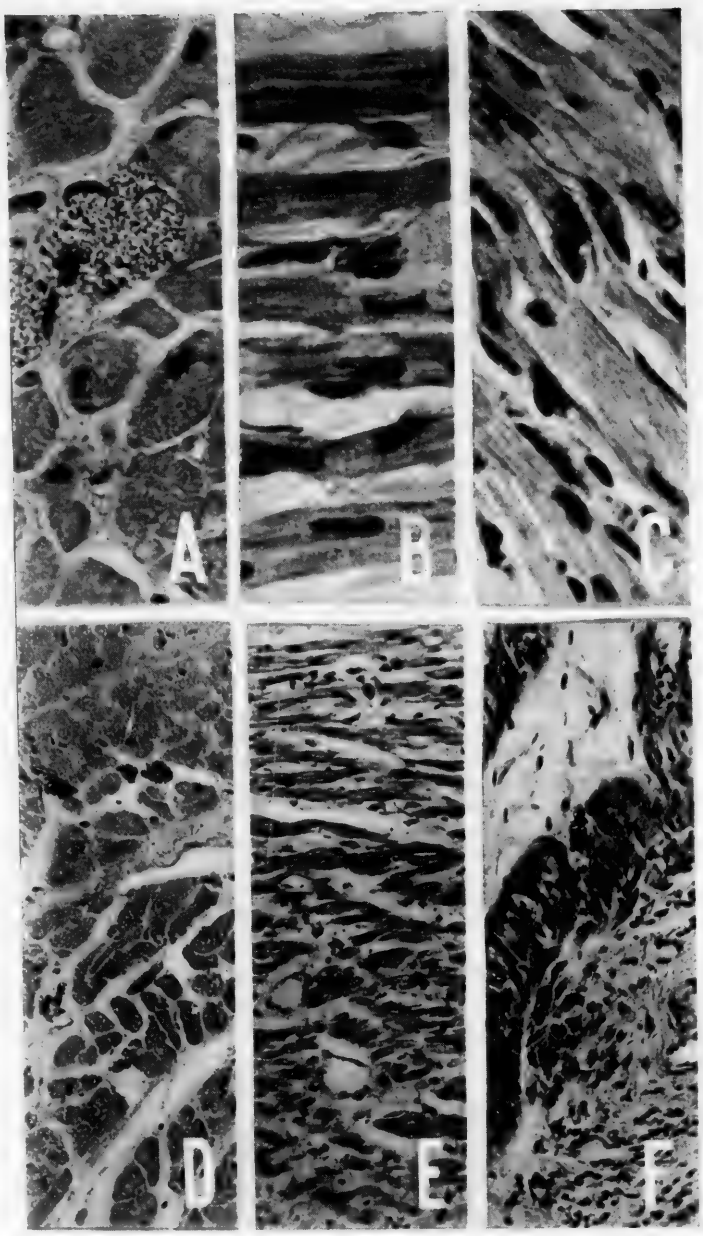

FIG. 5. PHOTOMICROGRAPHS OF MYOCARDIUM STAINED WITH HEMATOXYLIN AND EOSIN (SEE TABLE 1)

A, B and C: Thick (#6852), Normal (#864) and Thin (#5590) sections photographed with the 4 mm. objective.

D, E and F: Thick (#6852), Normal (#864) and Thin (#5590) sections photographed with the 16 mm. objective.

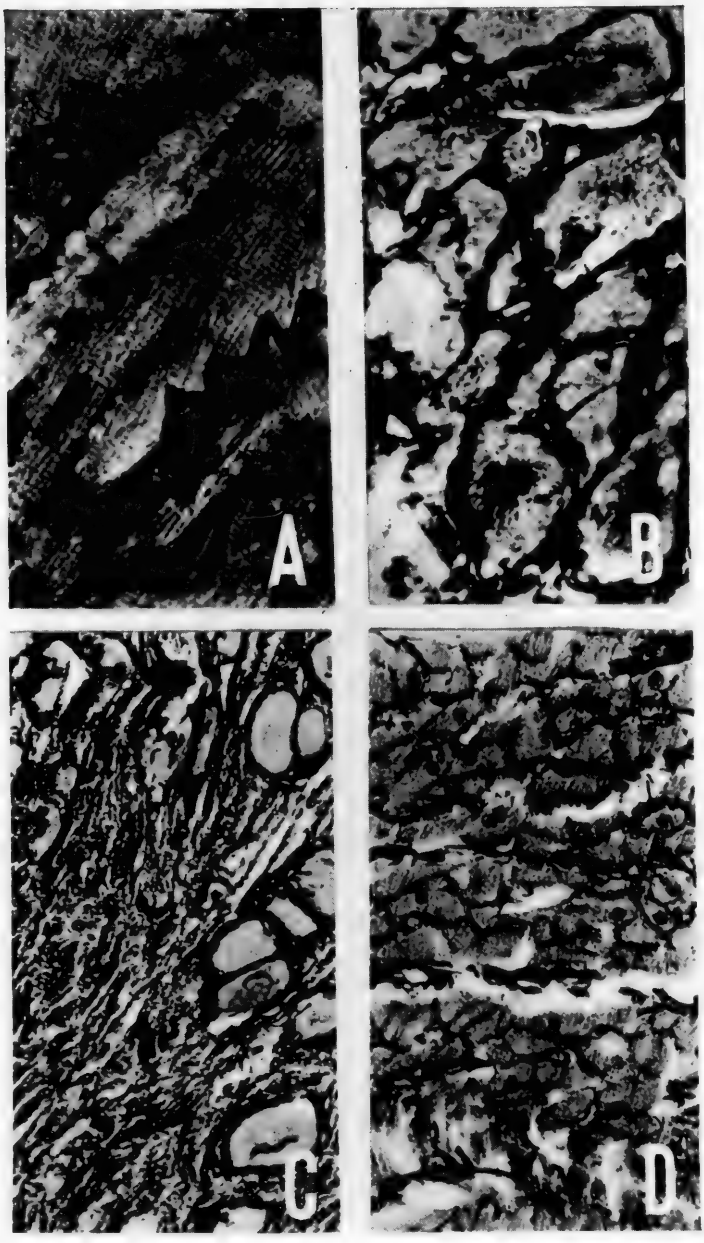

FIG. 6. PHOTOMICROGRAPHS OF MYOCARDIUM STAINED BY THE PAPP SILVER RETICULUM METHOD

A and B: Normal (*X402) and Thin (*X403) sections photographed with the 4 mm. objective.

D and D: Normal (*X402) and Thin (*X403) sections photographed with the 8 mm. objective.

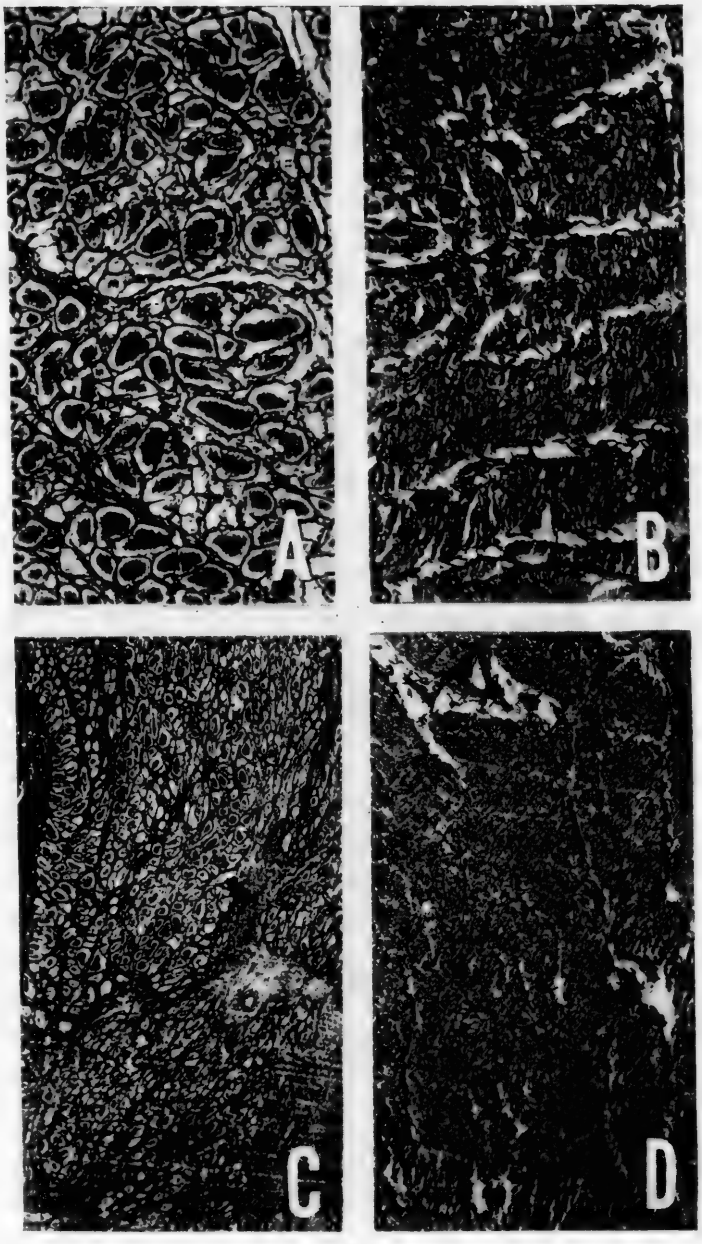

FIG. 7. PHOTOMICROGRAPHS OF MYOCARDIUM STAINED BY THE PAPP SILVER RETICULUM METHOD

A and B: Normal (*X402) and Thin (*X403) sections photographed with the 16 mm. objective.

C and D: Normal (*X402) and Thin (*X403) sections photographed with the 25 mm. objective.

possible for the inexperienced amateur to take excellent photomicrographs.

We wish to take this opportunity to thank Dr. E. E. Free for his suggestions and coöperation in the development of this instrument.

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A PHOTOGRAPHIC APPARATUS DESIGNED TO SAVE TIME AND LABOR*

JOSEPH B. HOMAN

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A problem that confronts the biological photographer today is the designing of apparatus which will do each type of work quickly, conveniently and efficiently. In planning equipment of this type it is possible to combine in one arrangement the means of doing various kinds of work, thus avoiding time lost in the setting up or duplication of apparatus.

The first apparatus to be considered (fig. 1) takes care of the following types of work, viz.:

Copies, up to 30″ x 20″.

Gross specimens, lantern slide negatives from books and all objects conveniently laid out flat. Having a bellows extension of five feet, small objects can be enlarged.

The apparatus is constructed mostly of 1 inch I. D. Pipe. It is 13 ft. high and takes up less than 8 ft. square of floor space. Vibration is overcome by braces, eight 1 inch flanges in wall and ceiling, and 6 lag expansion bolts in the floor. Situated at two different heights are platforms for the operator, which can be reached by means of ladders. Two lenses of 10 and 14 inch focal length are used. With the bulk of the work being done from the lower platform it is important that this platform be placed at a convenient height. This can be determined by the focal

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length of the lenses used. Centering of objects on the ground glass can be done from either platform by the aid of levers. Exposures up to one minute are made while standing on the platform.

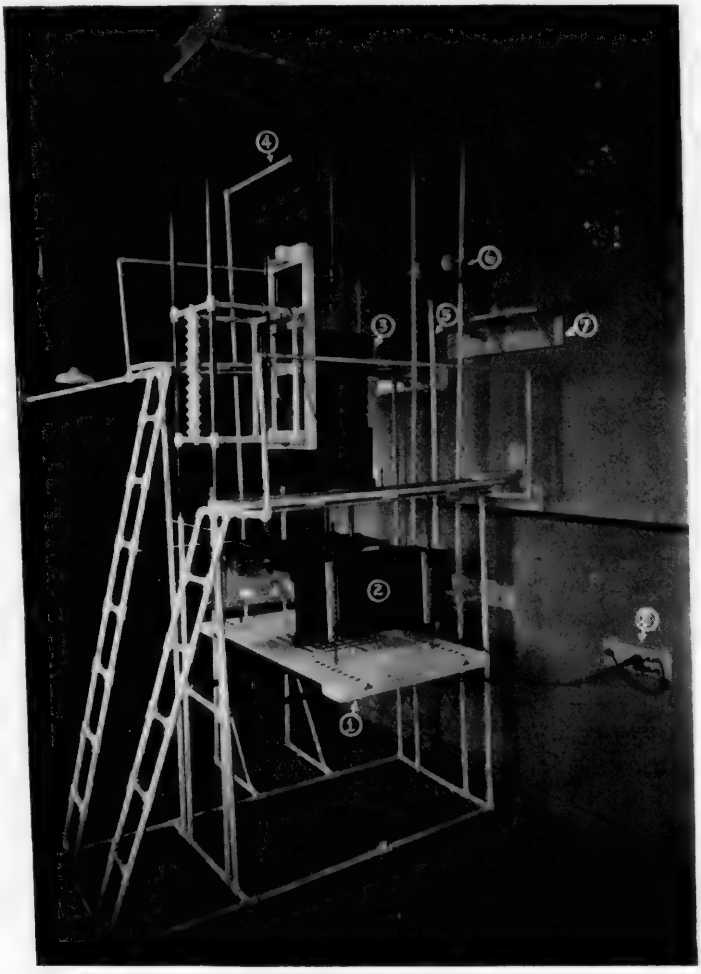

FIG. 1

DESCRIPTION OF FIGURE 1

No. 1 shows the object board which is 60″ x 36″, and grooved to take the light angles. It is mobile, moving right and left, forward and

backward by the aid of levers, Nos. 4 and 5. This board is 3 ft. from the floor, making a convenient working height. It is marked off with center and parallel lines. Objects to be photographed when placed parallel with the lines on the board, are also kept parallel with the lines on the ground glass of the camera by an arrangement under the board.

The light angles are marked Number 2. Each contains 5–100 Watt bowl frosted incandescent lights, each light of which has a separate switch. These angles can be moved forward or backward on steel shoes which slide in grooves on the board. They can also be moved up or down on rods and set at the proper height. The lights are on boards which can be moved in and out, inside the angles. The apparatus is equipped with a spotlight for lighting small objects to emphasize points of interest, or details in areas that are not reached by general lighting.

No. 3 shows a Folmer and Schwing 8″ x 10″ enlarging, reducing and copying camera with a 5 ft. bellows extension. It is held rigid by a lever and a set screw from the upper stand. An adjusting screw raises or lowers the camera 18 inches. If this is not sufficient, the set screw to the upper stand is loosened and the camera and support are moved up or down with the aid of a counter-weight on the pipe slide by drum No. 6. As the lens is generally used in the middle compartment which is movable, we have another means of racking the lens up or down. The final focusing is done with a micrometer focusing screw and focusing magnifier.

Nos. 4 and 5 are levers which pull the object to a center on the ground glass. They have a point of leverage which makes movement of the board quite easy. Centering the object is accomplished while looking onto the ground glass, it being unnecessary to go down the ladder for adjustment. Lever No. 4 swings to one side when the upper platform is used.

No. 6 shows the drum that is used in winding the camera up or down with the aid of a counter-weight.

No. 7 is a shelf upon which unexposed and exposed plate holders are placed.

No. 8 denotes a switch for controlling light. When objects are photographed under glass or liquid the lights can be adjusted to avoid reflection into the lens. If, however, a large chart under glass is to be taken, a piece of heavy black cardboard is attached to the front of the camera, thus avoiding all reflections from above. The apparatus has a wooden rod suspended along the side of the camera on which are written the object sizes and exposure times for plates and films.

FIG. 2

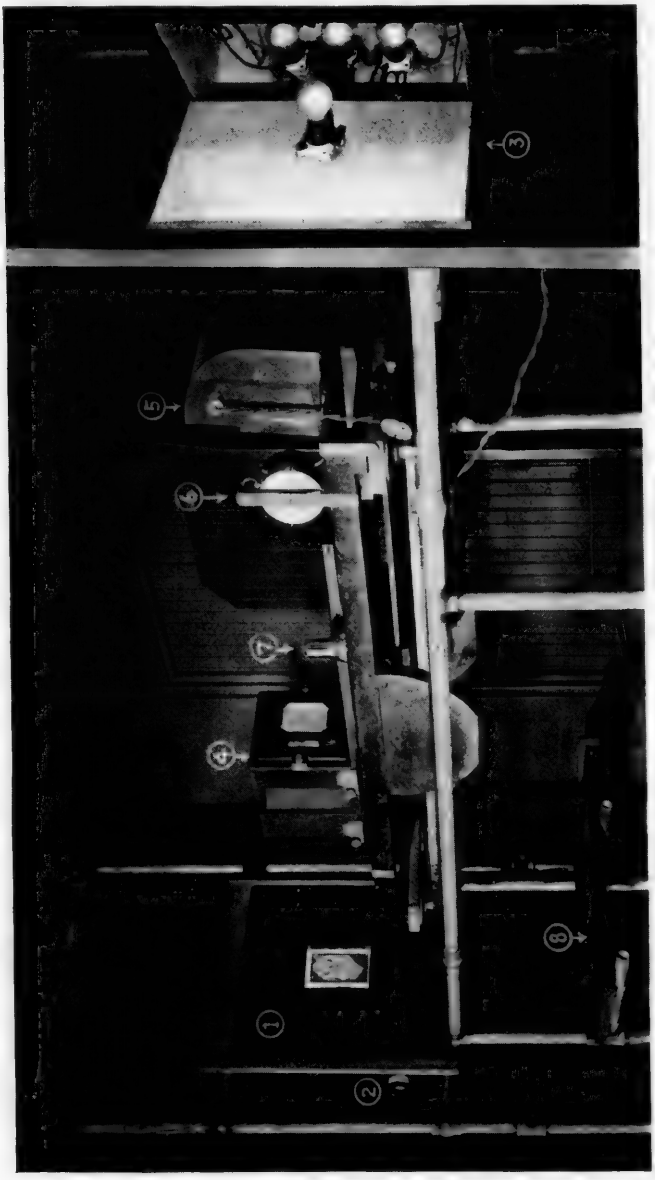

FIG. 3

DESCRIPTION OF FIGURE 2

For the photography of Surgical Specimens a flat light box (No. 1, fig. 2) is placed in the center of the object board. The top of this light box is a piece of ground glass upon which the specimen is placed. During exposure the lights in the box are turned on briefly, insuring an absolute white background in the finished print.

If, however, after carefully drying the specimen there is seepage beyond its edge, the background of the negative will have to be opaqued. The author does not recommend the immersion of specimens in water or other fluids except in rare cases due to their tendency to produce flatness of field. Attached to the upper edge of the light angles and working on rollers are diffusing screens (No. 2) which can be raised or lowered. In the picture on the right hand No. 3 shows the camera set up with a spot light (No. 4) for the enlarging of small objects that are placed with the light box (No. 1).

The technic to be employed in the photography of surgical specimens, depends on the type of specimen. If the specimen, after being washed and dried, is well marked in color and has rugged contours, but still has the objectionable sheen, formed by highlights, it is advisable to use the diffusing screens. If, however, the specimen has but slight variations in color and the surface has little or no modeling it is advisable to dispense with the diffusing screens, as they only add to the general flatness of field. In the photography of slightly colored specimens, when the color bears an important relation to the pathology of the specimen, it is important not to over-correct for color as a flatness of field may result.

The apparatus in figure 3 is used for the reduction and enlarging of plates or films. It is equipped with kits (No. 1) ranging in size from 14″ x 17″ to $3\frac{1}{4}$″ x 4″. The light box (No. 2) contains 9–40 Watt lights, each having a separate switch. By the aid of a door in the rear of this light box (No. 3), lighting for large over contrasty X-Ray films can be controlled to some extent.

A Century Lantern Slide Camera (No. 4) is used with long bellows extension having inter-changeable backs of $3\frac{1}{4}$″ x 4″ and 5″ x 7″. It is possible to substitute an 8″ x 10″ Camera in place of the Lantern Slide Camera. This apparatus is equipped with a safelight (No. 5, Wratten O A) which illuminates the ground glass of the camera, thus making it possible to center the picture without the general lights in the room

FIG. 4. CONTACT LANTERN SLIDES

1, light tight box; *2*, lantern slide printing frame; *3*, centering light; *4*, exposure light; *5*, push button for exposure light.

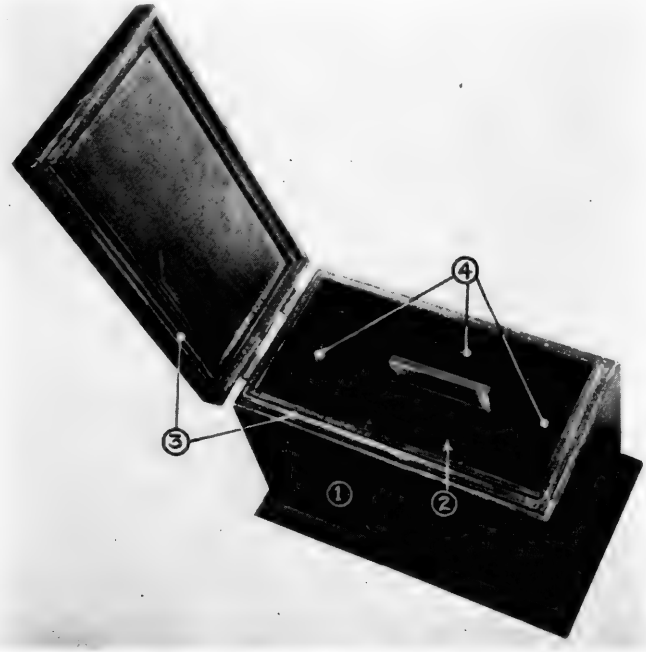

FIG. 5. *1*, light tight box; *2*, shelf to hold two dozen unexposed lantern slide plates *3*, edges which mesh on closing box; *4*, storage of exposed plates or films.

being needed. Adjacent to this light is a clock (No .6) for timing. No. 7 is a focusing magnifier and No. 8, a shelf.

In centering, the light box can be moved up or down by the aid of counter-weights, or from side to side, and held in position with set screws.

Figure 4 shows a set-up for making contact lantern slide plates. This apparatus is shown primarily to illustrate the use of the box (No. 1), in which unexposed and exposed plates are placed while making contact slides. This light tight box, shown in detail in figure 5, when not in use for making contact lantern slide plates, serves as a storage for exposed plates or films of 8″ x 10″ or smaller.

THE REVERSAL OF 16 MM. POSITIVE FILM OR MOVIES FOR APPROXIMATELY A CENT AND ONE HALF PER FOOT*

E. J. ROY

From The Kankakee X-Ray and Clinical Laboratories, Kankakee, Illinois

The ordinary title making film as supplied by the various manufacturers for about $1.60 per hundred feet can be easily reversed by the method herewith outlined. The equipment described allows the handling of 25 feet lengths and requires about 20 minutes for each batch. However, more film can be processed with larger equipment. Positive film is fast enough for most motion picture work, where color rendition is unimportant.

In exposing the film allow for its lack of speed; however, bear in mind that a slight under exposure is better than overexposure. The timing should be such that the entire film is as uniform in exposure as possible.

A processing hanger 12 x 10½ inches is made from *monel* metal. This holder is merely a flat rigid sheet (18 or 20 gauge) cut to the above dimensions with a notched semicircle of the metal soldered on each end. The spacing of these notches or rather tabs of metal is so arranged to utilize most economically the available space. The film is started on the hanger by being secured to a small clip soldered in one corner of the hanger which is then wound with film until filled. The other end is secured with a small clip tied to a rubber band with its end hooked over a metal

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tab. This rubber band helps to take up the slack as the film expands from water absorption.

After the film is on the hanger the following processing steps are carried out. It is first developed, then washed, exposed to strong light, bleached and finally redeveloped, fixed and rewashed. This sounds like a great deal of work but the entire procedure can be performed in twenty minutes.

The details of these steps are as follows: the loaded hanger is first developed for a normal time in the formula as specified by the maker of the film. If the result seems too contrasty it can be controlled in this development. Next wash the film for two minutes in running water. Now remove the film, and expose it to the light supplied by two 60 watt bulbs at a distance of about two feet. The hanger must be slowly revolved. For this purpose it should have a small handle soldered one on each side. If two one hundred watt lamps are placed about six inches behind a ground glass diffusing surface it makes a much better arrangement. Exposure time is $\frac{1}{2}$ to 2 minutes depending on the density of the negative. It may seem ridiculous to expose a sensitive emulsion to such strong illumination as is required in this printing procedure but the author has experimented with all degrees of light intensity and found this best. If the margins of the film turn brownish on exposure to light it indicates insufficient washing after the first development.

The film is now ready for bleaching. The bleaching solution may be kept in a ten gallon crock. The formula is as follows:

potassium bichromate, 40 grams
sulphuric acid, 37 cc.
water to make 10 gallons

The bichromate is first dissolved in water, the acid added, and then the mixture boiled before diluting to the ten gallons. Its life is indefinite. The bleaching is done in orange light, as are all subsequent steps. The negative is now placed in the bleaching bath and left there until all traces of black are removed. There is a residual yellow image visible as the film is transferred to the water where it is to be washed for three minutes. The water must be free of hypo and the film must not be touched with the hands or blackish fogged areas are likely to occur.

After the three minute interval in running water the film is redeveloped in the original developer containing a double amount of potassium bro-

mide. The development is somewhat slower and one unfamiliar with the procedure may doubt that any image will appear after a few minutes in the tank has elapsed, but rather suddenly the borders will blacken and the positive image is apt to be too dark before it is realized. Now wash for a few seconds and fix. Wash again for a half hour after fixation.

This method works well with three different brands of positive film. As these films all have very fine grain, they are excellent for technical work. The author has also successfully used this formula with regular negative orthochromatic and panchromatic stock. In the latter case the hanger must be loaded in total darkness which is at first difficult.

Perhaps the most difficult part of the whole procedure is to obtain a uniformly exposed negative. If one knows where to cut a film, in which a portion has more exposure than the rest, it is better to do so and make two batches of it, as the part with the heaviest exposure is sure to print too lightly.

Any communications on this subject will be gladly answered by the author.

COLORED LANTERN SLIDES OF PHOTOMICROGRAPHS FROM A SINGLE NEGATIVE*

CHARLES GOOSMANN, M.D.

When a section of tissue stained with Hematoxylin and Eosin is photographed with the usual green screen, the photomicrograph shows the Hematoxylin stain as the shadow and the Eosin stain as the half-tone. This makes it possible to get a two-color reproduction of the original blue and pink section from a single black and white negative. By making a thin lantern slide and toning with one of the well-known blue toners (iron ferricyanide), the Hematoxylin part of the image is blue with a greenish cast. If the lantern slide is immersed in a weak aqueous solution of Eosin, the half-tones show the pink color, while the shadows develop a truer blue. This method is very simple and practical for duplicating Hematoxylin Eosin slides so long as there are no high lights.

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In other words, if there are clear spaces in the lantern slide, they will stain with Eosin instead of being entirely colorless. If the clear spaces are large and not too numerous one may paint them with lantern slide varnish and allow the varnish to dry before counterstaining with Eosin. Orange G, or Biebrich Scarlet may be used instead of Eosin, for different color effects. Lantern slides colored by this method twenty years ago show no change in color, but they were not often exposed to strong light. In recent years research workers in photography have given us more selective toning solutions, and the following method will keep the high lights clear, although it is more difficult to use. It may require two or three lantern plates to get one that is entirely satisfactory, as the different negatives may require different timing in the development and toning of the lantern plate.

Starting with the negative, it is well to use a contrast developer:[1]

Solution A

	Metric
Water	1 liter
Hydrochinon	45 grams
Sodium sulphite (dry)	30 grams
Sulphuric acid	4 ccm.

Solution B

	Metric
Water	1 liter
Sodium carbonate (dry)	30 grams
Potassium carbonate	90 grams
Potassium bromide	8 grams
Sodium sulphite (dry)	90 grams

To develop in either tray or tank, take equal parts of A and B. By developing ten or fifteen minutes, at seventy degrees, great contrast is obtainable.

From the negative a thin lantern slide is made, preferably with three different trial exposures on the one slide. The time and temperature of the lantern slide development should be watched, as a variation of the time of development may improve the subsequent blue toning. After fixing and washing, the lantern slide is toned in the following solution:[2]

[1] Cramer's Manual on Negative Making, G. Cramer Dry Plate Co.

[2] Lantern Slides, How to Make and Color Them, Eastman Kodak Co.

Ammonium persulphate	0.5	gram
Iron and Ammonium sulphate (Ferric Alum)	1.3	grams
Oxalic Acid	3	grams
Potassium Ferricyanide	1	gram
Hydrochloric acid 10 per cent	1	cc.
Water to make	1	liter

Each of the solid chemicals should be dissolved separately in a small quantity of water, the solution then mixed in the order given, and the whole diluted to the required volume. This blue toning solution should color the shadows only, leaving the half-tones uncolored. After an intense blue tone is obtained (which may require twenty minutes), the slide is washed not longer than ten or fifteen minutes, and then bathed in the following solution:

Safranine A 0.2 gram dissolved in hot water and filtered; then add 5 cc. of 10 per cent Acetic Acid and dilute with cold water to 1000 cc.

In this dye toning solution the half tones become pink, but the high lights should stay clear. Washing should be followed by rapid drying with a fan. This two-color lantern slide is not grainy or opaque like an autochrome, but faithfully reproduces the Hematoxylin Eosin section. It is well to remember that the color of the lantern slide must be judged by projection on the type of screen which is to be used.

THE INVISIBLE PHOTOGRAPHIC SCREEN*

F. R. HARDING

From the Photographic Department, Children's Hospital, Boston, Mass.

In one type of clinical photography, the patient is photographed through a cross-lined screen. The screens used today are of many varieties. Some hospitals employ a string screen which is simply a large frame on a stand with white strings stretched both vertically and horizontally. The spacing of the squares thus formed is usually about one inch. Such a screen is used in front of the patient. Another method, is to paint the screen on the wall, and have the patient stand against it.

* Received for publication February 6, 1933.

The string screen is difficult to store when not in use, and the strings soon get very dirty. The painted screen is all right, if the photographer has quarters large enough to maintain more than one background. However, it must be remembered that this screen shows in back of the patient, rather than in front. In this way it does not divide him off in squares. Both the string and painted screens alarm some patients, especially children. Another objection to either of these screens is, that

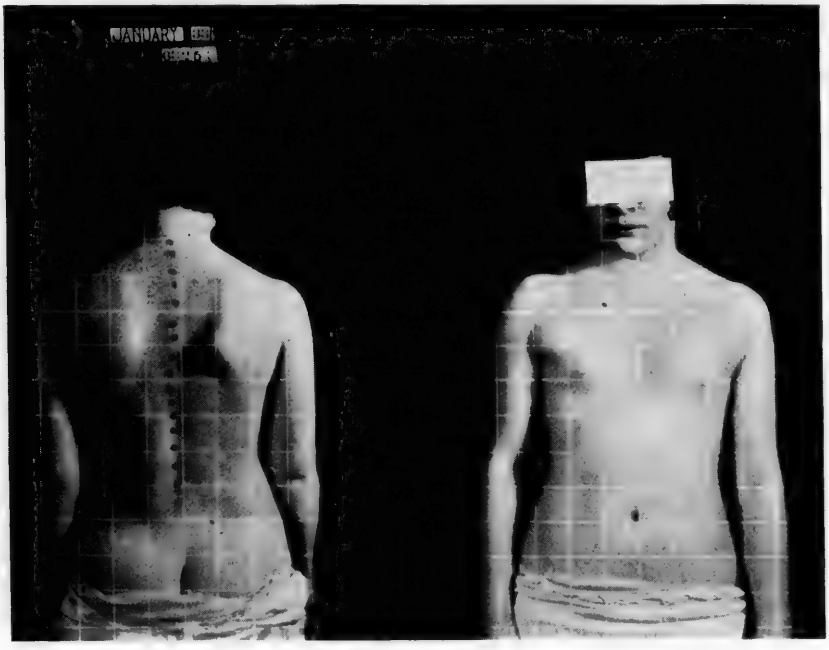

FIG. 1. THE SCREEN IN USE

some one may want an unlined picture later, when the patient is no longer available.

At the Children's Hospital, we have developed what might be termed the "invisible screen," because the patient never sees it. It consists of a piece of thin celluloid the same size as the negative that is to be used. This sheet of celluloid is scored with cross-hatched lines one quarter inch apart. The scoring is done with a scribing tool or the point of a knife. Care must be taken not to cut too deeply or the celluloid will

split if it is bent. After the scoring is completed, red or black wax crayon is rubbed into the lines, and the sheet polished with a soft cloth.

To use the screen, lay it on the glass of the printing machine, place the negative on *top* of it and make the print in the usual manner. The result will be a positive covered with fine white, crossed lines.

As a guide in registering the screen with the negative, a thin, true vertical line is made on the background. This line should show somewhere on the negative. When ready to print, simply register the background line with one of the screen lines.

We use this screen routinely on cases of scoliosis, torticollis and bow legs. It is used on nearly all orthopedic photographs where any deformity is visible; also for showing symmetry of the face, etc. New uses are constantly suggesting themselves.

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It will be sent free of charge to doctors or hospital executives on application to the Educational Division, Bell & Howell Company, 1801 Larchmont Avenue, Chicago.

Photographic History

Theories of the past become realities of the present and mentors of the future

THE DEVELOPMENT OF PHOTOGRAPHIC CHEMISTRY

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Photography in the broad sense is the process of forming and fixing an object by the chemical action of light. Chemistry in the same sense is a branch of science which deals with the composition of matter and the changes which it undergoes through the action of various agencies. In considering such a definition, however, one should distinguish between *physical* and *chemical* changes. Otherwise this subject treats of matter considered as composed of atoms and of their relations and affinities.

When we combine these two definitions using the phrase "photographic chemistry" we limit the latter to its application to photography alone. However it is a known fact that the photochemical action of light had been studied long before photography became a living, working science.

In fact as early as the time of prehistoric man some of these ancients must have observed the tanning or bronzing of the human skin by the solar rays. Possibly the black skin of the negro may be assigned to such a cause since he was known to be scantily clad and constantly beneath the intense rays of a tropical sun.

Aristotle who lived more than 300 years before Christ observed that plants which were bleached practically white by being stored in the dark became green on exposure to light.

About two hundred years later the Roman philosopher, Pliny, noticed and recorded the fact that yellow wax is bleached by exposure to sunlight. He also noticed the action of the atmosphere on silver. These observations were evidently only a record of the effect of the atmosphere on metallic silver. The Greeks knew well that certain gems, the opal and the amethyst especially, lost their luster from exposure to sunlight.

The Great Roman architect and painter, Vitrivious who lived in the age of Augustus (63 B.C.–14 A.D.), was so conscious of the decolorizing effect of sunlight that he invariably placed his paintings in rooms facing the north where they would not absorb its direct rays. Jabir Ibn Hayyam who was an Arabian and often called Geber observed in the eighth century the darkening of silver nitrate when it was exposed to the action of the atmosphere.

Geber prepared nitric acid, dissolved silver in it and obtained silver nitrate in crystals. He added sal ammoniac (ammonium chloride) to nitric acid and so obtained aqua regia with which he dissolved gold and other substances. He says that he also dissolved silver in it. When aqua regia acts on this metal, silver chloride is produced. It is very likely that he added sal ammoniac to the solution of the silver in nitric acid. In such a case silver chloride would have been precipitated as a white insoluble powder.

Such observations as preceding this latter one could hardly be considered the results of scientific study. However, it is to the alchemists of the early Renaissance that most historians give the credit for discovering the basic principles of photographic chemistry. These alchemists have been subject to much calumny. It is true that among the adepts of the "black art" there were numerous charlatans and quacks, however it must not be forgotten that a large number of the philosophers of the middle ages were men of indefatigable research. They were possessed with a real love of their art which they cultivated if not with method at least with invincible perserverance. It was one of these laborious workers who first produced chloride of silver.

This disciple of Hermes was named Georgius Fabricus. In the sixteenth century, he experimented with "horn silver" or *luna cornea* as it was then termed. Horn silver is a semi-transparent compound of silver and chlorine which occurred as an ore in the silver mines of Germany but which Fabricus found could be prepared by adding a solution of common salt (sodium chloride) to a solution of silver nitrate. Imagine his astonishment when he perceived that this substance, as white as milk, became black as soon as the rays of sunlight fell on its surface for a short while.

Gaston Tissandier claims in his *History and Handbook of Photography* that Fabricus in his *Book of the Metals* published in 1556 relates that the image projected by a glass lens on to a surface of "luna cornea" imprinted itself in black and gray, according as the parts were completely illumi-

nated, or touched only by diffused light. But here Fabricus stopped. He lets this fact, so full of significance, escape him to persue a fancy—the philosopher's stone. He wanted to change baser metals into gold. The science of those times was practically powerless through want of method. It ignored the art of inferring from observation and of confirming by experiments the deductions thus obtained. The chemists of this epoch could not see because their eyes had not been trained to look.

A great step forward might have been taken had Fabricus been able to read and put into practice Leonardo's description of his camera obscura. This description had been written about fifty years previous to, but not published at the time Fabricus made his experiments with silver chloride. The art of photography might have been four hundred years old in our present day instead of being in existence for less than a century.

In about 1686, Boyle an early English chemist wrote of the sensitiveness of gold. A Russian field marshall of about this time prepared a remedy in which ferric chloride was used. The action of light reduced the chloride to the ferrous state.

The fact that the darkening of silver salts is due to light rather than the action of various vapors of the atmosphere was first definitely recorded in 1727 by Johann Henrich Schulze, a German chemist. Schulze found while experimenting with a solution of chalk and aqua regia which accidentally contained a trace of silver that the surface of the solution which was exposed to light had changed to a dark purple color. The body of the solution that had not been affected remained the same. He then prepared a fresh solution of chalk and aqua regia that was free from silver but noticed that no change in color took place. From these experiments he gathered that the trace of silver was affected by light and had caused the change.

W. Jerome Harrison in his book *A History of Photography* says that Schulze actually obtained copies of writing by placing the written characters upon a level surface that had previously been prepared with a mixture of chalk and silver nitrate solution. The rays of sunlight passing through the translucent areas blackened the surface beneath except where the ink formed the letters.

C. B. Neblette in his book *Photography, Its Principles and Practice* ventures no further than to say that Schulze cut a stencil in opaque paper and placed it around a bottle containing a mixture of chalk, aqua regia and silver, then exposing it to the light. In this way the words or sen-

tences were accurately and distinctly reproduced on the chalk sediment.

Up to this point we have Fabricus and Schulze who both claim to have produced an image more or less distinct on a solution or surface containing silver salts. The former by the use of a glass lens as in projection and the latter by contact as in contact printing. However, neither made an attempt to use the camera obscura or to "fix" the image that they obtained. For this reason it is hardly fair to call either the "Discoverer of Photography" as Eder and others will have us believe.

Charles William Scheele of Stralsund (then a Swedish town) was a distinguished investigator and considered one of the founders of modern chemistry. In 1777, he made the first scientific investigation of the behavior of silver chloride under the influence of various colored lights. He showed that while the silver salt was quickly darkened by violet or blue light, the red and yellow rays had much less effect upon it. These results were confirmed by Senebier in 1782 who worte "in fifteen seconds the violet rays blackened silver chloride as much as the red rays did in in twenty minutes." Scheele proved that the effect of white light upon silver chloride was to decompose it and cause it to give up some or all of its chlorine.

There are others such as Boulton in 1777, Charles in 1780 and Lord Braughan in 1795 who did interesting photographic experiments, but their work has been somewhat too vague to place them among the foremost workers in this subject. However, it may be well to mention Herschel who in 1800 discovered the heat rays beyond the visible red, also Ritter who, a year later, discovered by photographic means the existence of the very active ultraviolet beyond the visible violet. This brings us to Wedgwood and Davy.

Thomas Wedgwood and Humphrey Davy experimented along similar lines. Davy found that silver chloride was more sensitive than the silver nitrate. They managed to record images of small stationary objects on paper and white leather coated with silver chloride. This was done by placing an object such as a leaf on the coated surface and exposing it to sunlight. The unprotected portions darkened while the protected portion remained white. They also tried using this coated paper under paintings on glass. The rays of light passing through the transparent and semi-transparent portions gave them a picture. They possibly were the first to experiment with the camera obscura by hanging a piece

of their coated paper opposite the lens, but found it too slow for the action of light to make much impression on it. The foremost problem now was to find some way to preserve or "fix" the various silhouettes and printed pictures so that they would not fade. This Wedgewood and Davy never managed to do. Possibly the early death of Wedgewood at the age of thirty-one had a great deal to do with this failure, for their experiments stopped here. After this man's death a joint paper evidently written by Davy was brought before the Royal Institution and published in 1802 under the title *An Account of a Method of Copying Paintings upon Glass and of Making Profiles by the Agency of Light on Nitrate of Silver* by T. Wedgewood with observations by H. Davy.

One of the outstanding photographic experimenters was the Frenchman Joseph Nicephore Niepce, who was born at Chalons-sur-Saone on March 7, 1765. While Niepce did a great deal to advance photography from many angles we will consider here mainly his study of photographic chemistry. One of his important experiments was that he substituted a metal plate for the lithographic stone and the use of "Jew's pitch" or bitumen—a kind of asphalt as a coating. Niepce did this in order to save the lithographer labor in drawing. He dissolved and prepared this substance as a varnish, and put it on the surface as a film. This film of varnish when exposed to light would show no signs of change, but when the light acted it became less soluble. On applying a weak solvent, such as a mixture of oil of lavender and petroleum oil, the parts that were not changed by the action of the light would dissolve more readily than the other parts. In due time a drawing in outline was reproduced by this method. By further treating this plate with acid, an image in relief was produced from which prints could be made in an ordinary print press.

Niepce used the camera obscura as early as 1826 giving an exposure of six to eight hours. He was the first to discover a process by which a permanent reproduction could be made by photographic means.

Louis Jacques Mande Daguerre is undoubtedly the best known of all of the early research workers in photography. This is due to the fact that he invented the first practical photographic process known as the Daguerreotype.

Daguerre was born at Cormeilles, a village near Paris on November 18, 1787. He was educated in the public school and at an early age manifested a desire to draw. At the age of thirteen he was attributed with producing very creditable portraits of his parents. At the age of sixteen

he left Orleans, where his family now lived, for Paris and entered the studio of Degotti, a celebrated scene painter of this time. Daguerre not only became a genius at landscape and scene painting but soon excelled his master. He was one of the first to develop the art of stage lighting and invented a diorama that permitted a quick changing of scene. In his scene painting he continuously used the camera obscura, becoming familiar with its principle between the years 1816 and 1821. In about 1824 he began to make experiments towards the permanent recording of the images produced by this instrument. For such work he collaborated with Chevalier an optician and Joseph Nicephore Niepce. With the latter he formed a partnership that continued until Niepce's death in 1833.

After the death of Niepce, Daguerre continued his research most zealously in collaboration with the son of his former partner. This son was named Isidore. They met with such great success that the French government gave a yearly life pension to Daguerre of 6000 francs and to Niepce, 4000 francs. The money was given on the condition that the invention be published without patent. The agreement was accepted by the partners and in August, 1839, the details of the process were made public before the *Academie des Sciences*.

Their method of procedure was to use a highly polished plate of silvered copper on which a film of iodide of silver was allowed to form by subjecting the silvered surface to the vapor of the iodine, forming iodine crystals. As the iodine evaporated the vapors came in contact with the silver and formed silver iodide. The coated plate was then exposed in the camera and developed by the action of the vapor of metallic mercury. This discovery of a method of bringing out the latent image was one of the greatest steps forward in the development of photography. These two experimenters also perfected a method of making the finished picture permanent by fixing it in a solution of common salt.

The Daguerreotype is really not a positive but a negative of exceeding thinness. This being the reason that the early Daguerreotypes were reversed. Such a fault was overcome, however, by interposing a mirror or a reflecting prism between the lens and the subject. The greatest difficulty now to overcome was the fact that only one picture could be made with each complete operation.

About this time, another experimenter by the name of Bayard was working on a method of producing a positive direct on paper. He ex-

hibited samples of his work on June 24, 1839 which was two months before the Daguerreotype process was announced to the public. Bayard's procedure was as follows: Paper was soaked in a solution of ammonium chloride, dried and floated on silver nitrate. After re-drying in the dark it was exposed to daylight until completely darkened. It was then placed in a solution of potassium iodide and exposed while wet in the camera. This gave a positive by the action of light acting as a bleach on the paper. The picture was then washed and fixed in potassium bromide. Such pictures that were made by this procedure were permanent.

While Daguerre was pursuing his researches in France another worker was advancing towards the same photographic goal in England. His name was Henry Fox-Talbot who was born in February, 1800. He was of high lineage, being one of the oldest families in England and a graduate of Cambridge with high honors in 1821. For two years he sat in Parliament but tired of political life and so in 1834 he began to devote his time to scientific research. He was a versatile experimenter and published many worthwhile papers in various scientific periodicals. On the 17th of September in 1877 he died at his family seat, Lacock Abbey, in Wiltshire.

Fox-Talbot worked along similar lines as Wedgwood and Davy. He sent two communications to the Royal Society in 1839 showing that he had obtained a much greater sensitiveness than the early workers and had succeeded in "fixing" the results. Silver chloride was used for his sensitive medium to impregnate the paper. "Fixing" was accomplished with a weak solution of potassium iodide or a strong solution of common salt.

Early in 1837 Rev. J. B. Reade found that by tanning the paper with an infusion of galls in addition to the silver salts the sensitiveness of the paper was greatly enhanced. This paper so prepared could be used in his camera. He obtained a photograph of a flea by means of his microscope giving an exposure of less than five minutes. He also obtained photographs of sections of wood using exposures from eight to ten minutes. Reade used sodium hyposulphite for dissolving out the silver salt that was unaltered by light.

Two years after these experiments Fox-Talbot effected a great advance in sensitiveness of paper making it more than a hundred times as sensitive as it had been before. He found that he could produce a latent or

invisible image that could be brought out by developing. This method he called the "calotype process." Photographs were produced in the following way:

Paper was impregnated with silver iodide and shortly before use was washed over with a mixed solution of silver nitrate and gallic acid. It was then exposed in the camera, after which no change was visible. On removal the paper was washed over a second time with more of the gallic acid and silver solution and gently warmed over a fire. The image gradually appeared and grew to an intense blackness. By using this process photographs of buildings in the sunshine could be made with an exposure of one minute through an ordinary slow view lens. With a rapid portrait lens a white bust in sunshine required only one second exposure. These paper negatives were used to print by contact.

Sir John Herschel suggested the use of glass plates as a support for the sensitive silver salts. He recognized the transparency, rigidity and cheapness of glass together with its indifference to the action of the chemicals employed. Herschel also suggested the use of hyposulphite of soda as a fixing agent, and contributed the blueprint or ferro-prussiate process so common today.

In 1846 Schonbein, a Swiss chemist, discovered gun-cotton which was later adopted to photographic use. He treated ordinary cotton fibre with aqua regia a combination of nitric and hydrochloric acid. This so altered the cotton that it became soluble in a mixture of alcohol and ether thereby forming collodion.

Blanquart-Everard in 1848 applied an albumen coating to paper for printing. This albumen acted as a sizing for the silver salts and prevented this sensitizing agent from sinking into the paper.

In 1849 a Frenchman by the name of Gastave Le Gray suggested that collodion might be useful in photography. In his book he writes:

> I have just discovered a process upon glass by hydrofluoric ether, the fluoride of potassium and soda dissolved in alcohol 40 degrees Fahrenheit, mixed with sulphuric ether and afterwards saturated with collodion. I afterwards react with nitrate of silver and thus obtain proofs in the camera in five seconds in the shade. I develop the image with a weak solution of sulphate of iron, and fix with hyposulphite of soda.

Robert J. Bingham as assistant to the great Faraday used collodion immediately on its introduction into England in 1847. In a book published in 1850 he first gives Herschel's method and then a method using albumen and another for coating glass plates with isinglass. He finally

adds, "We may, in the place of gelatine (isinglass) employ a number of other substances to form an adherent film upon the glass. The following are a few we have experimented with and found to answer moderately well—gluten, collodion, varnishes, etc."

Although Le Gray and Bingham suggest the use of collodion the invention and publication of the process properly belongs to Frederick Scott-Archer. His article describing the procedure first appeared in a London periodical called *The Chemist* in March, 1851. The principles of Scott-Archer's process are as follows: Gun Cotton was dissolved in a mixture of alcohol and ether. To the collodion that was thus obtained iodides and sometimes soluble bromides were added. This was poured on the glass plate and allowed to set through evaporation. The plate was then plunged into a bath of nitrate of silver in order to impregnate it with iodide and bromide of silver. Charged with these insoluble compositions, and covered with free nitrate of silver, the plate was exposed. It was then removed to the processing room and submitted to the action of reducing agents such as pyrogallic acid and sulphate of iron. The latent image became a visible negative picture. After development the image was made prominent by depriving it of the still sensitive and unaffected salts by means of hyposulphite of soda or potassium cyanide. From such negatives as Scott-Archer obtained in this way he could produce by contact as many positives as he desired. This was known as the "wet plate process."

The dry plate process was worked out by Taipenot in 1855. He used gallic acid, honey and albumen as preservatives to prevent the crystallization of the silver nitrate which occurs when a sensitized wet-collodion plate is allowed to dry. In overcoming this crystallization he also overcame the unevenness of the action of exposure and development.

In 1871 Dr. Richard Leach Maddox substituted a solution of gelatin in water for the solution of collodion in alcohol and ether. He worked out the first usable method of preparing gelatino-bromide emulsions and described his procedure in the *British Journal of Photography* for September 8, 1871. The essence of this article showed that silver bromide was formed in the presence of gelatine, the emulsion containing an excess of silver and a small amount of aqua regia. This emulsion was coated on glass plates, dried and exposed. The negatives obtained were developed by using pyrogallic acid and then intensifying with pyrogallic acid and silver nitrate.

Since this time, wonderful improvements have been made in photographic procedures. Among these are the development of natural color processes and the substitution of the celluloid base for the glass plate. This celluloid base was invented by Dr. Goodwin and George Eastman is given credit for its practical application. Both of these men were Americans.

Not only have the chemical constituents of the plate or film itself been greatly improved but the chemistry of development has also become more perfected. Printing papers have taken various surfaces and chemical qualities for individual needs. Photography has branched out into many processes that have been adapted to hundreds of uses. In fact we do not consider it out of the ordinary to photograph the tiniest microbe bringing it to a size that is plainly visible, or the great mass of one of the planets.

Photography has not yet reached its peak of perfection. It is safe to predict that even greater achievements are in store for it in the future. It is not illogical to reason that some day natural color photographs on paper of good quality will be made as easily as the present black and white prints. Imagine the astonishment of any of the early experimenters if they could return to see a modern talking motion picture.

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